EXTERNAL SCIENTIFIC REPORT

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Statistical analysis on the EPILOBEE dataset: explanatory variables related to honeybee colony mortality in EU during a 2 year survey

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Abstract

Seventeen Member States of the European Union were brought together to set up the first EU-wide active epidemiological surveillance program on honeybee colony mortality (EPILOBEE) based on representative beekeeper populations of randomly selected apiaries and colonies from 2012 to 2014. Visits were performed to estimate the mortality of bee colonies over the winter and during the season. Beekeeping practices and clinical signs of the main honeybee diseases were recorded through a questionnaire. Winter and seasonal mortalities widely varied according to the Member States and when comparing both years. The highest winter mortality was recorded in Belgium in 2012-2013 (31.73%) and the lowest in Lithuania (2.16%) in 2013-2014. In the multivariate Poisson regression models combining both years, the country was studied as a random effect. Using a hierarchical clustering of observations, the highest winter mortality rate (14.04%) was affected to a cluster including hobbyist beekeepers over 65 years of age with small size apiaries, with a production including queens and a small experience in beekeeping. The lowest winter mortality rate (8.11%) was affected to a cluster with professional beekeepers between 30 and 45 years of age, with large migrating apiaries. The management promoted the increase of the livestock. These professional beekeepers had attended a beekeeping training during the past three years, used an apiarist book, had a qualification in beekeeping, were members of a beekeeping organisation, and had an experience in beekeeping superior to five years. These apiaries did not suffer from any disease. Variables with a statistically significant effect on honeybee colony mortality during the beekeeping season were colonies clinically affected by the varroosis, the absence of beekeeping training during the past three years of the beekeeper's activity, the non-use of an apiarist book and the non-participation to a cooperative veterinary treatment. Being a pilot project, EPILOBEE was rich in lessons leading to the formulation of recommendations for future epidemiological surveys.

Key words: honeybee health, colony mortality, honeybee diseases, epidemiology.

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Summary

In 2008, EFSA commissioned a survey on existing bee surveillance systems in the EU and following its recommendations, the European Commission established an EU Reference Laboratory for Honeybee Health and funded an EU wide monitoring program on honeybee mortalities and diseases in Europe (EPILOBEE). This first active epidemiological surveillance program was implemented in 17 EU Member States, over 2 consecutive years (from autumn 2012 to summer 2014), following a harmonised protocol based on the EU reference laboratory guidelines.

At EFSA, the Scientific Committee and Emerging Risks unit is coordinating a multi-annual project (MUST-B) to address multiple stressors in honeybee colonies. EPILOBEE was considered as an important piece of evidence in terms of dataset and lessons learnt to be further considered under the project MUST-B.

The overall objective of the contract was to perform analyses on the EPILOBEE dataset to establish statistical associations between colony mortalities and some factors including disease prevalence, the context of beekeeping and the apiary geographical distribution.

EPILOBEE was designed to collect data in a standardised way on a representative number of apiaries and colonies in each Member State through onsite investigations. The sampling procedure was based on a two stage random sampling with apiaries as primary units and bee colonies as secondary units enabling representativeness.

Three visits were set up in each Member State for each selected apiary: before winter, after winter and during the beekeeping season (when honeybee activity is at the highest). If colonies exhibited clinical signs of a disease, samples were collected for subsequent laboratory analyses. The main honeybee diseases clinically investigated in the frame of this program were those regulated at the European (i.e. listed for notification or trade and import rules or for national eradication programs) and national level: the bacterial diseases, the American foulbrood and the European foulbrood, the parasitic disease varroosis, the fungal disease Nosemosis, and a viral disease caused by the chronic bee paralysis virus. During autumn visits, all the selected colonies were systematically sampled to assess the infestation by *Varroa destructor* mites. Case definitions and samples to be collected were detailed in the protocol provided by the EURL.

Data collected during the two years through field questionnaires and laboratory results were recorded in a European online database.

Five thousand seven hundred and ninety eight apiaries were visited three times during the survey (3 053 during the first year and 2 745 during the second year). In order to validate apiaries with consistent data, several checks were applied to the dataset. Finally, the data set was completed on 4 758 apiaries for the calculation of colony mortality (2 332 for the first year and 2 426 for the second year).

The number of variables collected during the program (138) was too large to all be included in the statistical analysis and was narrowed down to a set of explanatory variables. The selection was carried out by a group of experts on the significance of the variable as factor for explaining the mortality. Moreover, the completeness of the data and the format of variables were also considered, resulting in 36 explanatory variables selected for the statistical analysis. The two years under study being dissimilar, each year was firstly studied separately. Thereafter, an overall study including both years was conducted.

For each year, only univariate models (i.e. models which associate each explanatory variable with each dependent ones) were performed. They aimed at interpreting the relationships between each explanatory variable and the mortalities under study by means of quasi-Poisson generalised linear models. The p-value associated to the likelihood ratio inferior to 0.05 identified the explanatory variables having a statistically significant effect on the mortality under study. Contrasts were used to

compare each mortality rate (of each category) of the explanatory variable, to each other. In addition, each mortality rate (of each category) of the explanatory variable was compared to the empirical threshold of 10 % for winter mortality. For seasonal mortality, there is no empirical threshold for acceptable mortality. Therefore, each mortality rate (for each category) of the explanatory variable was compared to the European mean.

The overall study took into account both years of the study. It was conducted through five steps: (1) missing data imputation. In order to analyse a complete dataset, missing data were handled by means of an imputation method based on exploratory multivariate analysis. As the explanatory variables to be imputed were all categorical, the multiple correspondence analysis was used; (2) selection of the explanatory variables mainly related to mortalities. In order to eliminate explanatory variables which definitely will not have a great influence into the models, the 0.20 threshold was used: variables with a p-value superior to this threshold were eliminated from the study, while the ones with a p-value inferior to the threshold were selected for the rest of the study; (3) in order to avoid quasi-collinearity within explanatory variables, they were summarized throught five homogeneous thematics previously defined (variables related to diseases, apiary management, health events (i.e. high rates of colony mortality or honeybee mortality that have occurred before the start of the project), beekeeper background (i.e. training, knowledge, proficiency) and to the apiary size); (4) elaboration of a new synthetic variable. As generalised linear models may be affected by quasi-collinearity between explanatory variables, correlations between these variables were additionally controlled by means of chi-square tests. In the case of the five new summarised variables, they were still correlated with each other, all the new summarised variables were included in a multiple correspondence analysis followed by a hierarchical clustering. The clustering result was considered as the new explanatory variable to be included in the multivariate model; and (5) multivariate regression models. Finally and for the two mortalities to be explained, this new explanatory variable was included as fixed effects in mixed multivariate Poisson regression models, the country and year effects being considered as random effect in the analysis.

During the first year (2012-2013), the lowest winter mortality rates were recorded in Greece, Lithuania and Italy, the highest in Belgium. Sweden, Hungary, Portugal, Slovakia, Poland, Denmark, Latvia and Lithuania had the lowest seasonal mortality rates. The highest seasonal mortality rates were recorded in France and England and Wales. During the second year (2013-2014), Lithuania recorded the lowest winter mortality and was statiscally separated from all the other Member States. The highest winter mortality was recorded in Belgium, Estonia, Sweden, France and Denmark. Hungary, Estonia, Finland, Slovakia, Latvia, Poland and Lithuania were part of the group with the lowest seasonal mortality, France and Belgium recording the highest seasonal mortalities.

For each year of the survey, the seasonal mortality was statistically linked to the winter mortality for both years. Between years, winter and seasonal mortalities varied widely among the Member States. In the multivariate Poisson regression models combining both years of EPILOBEE, the country was studied as a random effect. The age, apiary size, operation size, beekeeping knowledge and training were found to be significant risk factors affecting the mortality of honeybee colonies during the winter and the beekeeping season in Europe in 2012-2014. Using a hierarchical clustering of observations, the highest winter mortality rate (14.04%) was affected to a cluster including hobbyist beekeepers over 65 years of age with a small size apiary, with a production including queens and with a small experience in beekeeping. The apiaries suffered from varroosis at the autumn visit. The lowest winter mortality rate (8.11%) was affected to a cluster with professional beekeepers between 30 and 45 years of age, with large migrating apiaries. In these apiaries, the management promoted the increase of the livestock. These professional beekeepers attended a beekeeping training during the past three years, used an apiarist book, had a qualification in beekeeping, were members of a beekeeping organisation, and had an experience in beekeeping superior to five years. The apiaries did not suffer from any disease at autumn visit. The variable with a statistically significant effect on honeybee colony mortality during the beekeeping season in Europe were colonies clinically affected by the American foulbrood, the absence of any beekeeping training of the beekeeper during the past three years of the

beekeeper's activity, the non-use of an apiarist book and the non-participation to a cooperative veterinary treatment.

The statistical significant link between the number of swarms bought, merged colonies, and colony losses might reflect the additional work needed by beekeepers to overcome colony losses: beekeepers got new swarms and merged colonies to maintain the livestock at an acceptable level in quantity and quality.

EPILOBEE being a pilot project was rich in lessons. For future epidemiological surveys, it is recommended to better adapt the protocol to the size of the project. The number of variables collected during the program (138) was too large to all be included in the statistical analysis. Beside the variables were highly correlated between each other. The study of some potential risk factors should be specifically targeted through dedicated protocols. EPILOBEE underlines also the necessity to have very specific care in assessing how bee inspector training, networking and data reporting is implemented in the Member States. Due to time constraint, the database was developed at the beginning of the field study. However, it is advised to develop the database before data are collected and to design it in a way that the data can be self validated and readily analysed. Data models using controlled terminologies and strict business rules would have avoided the need for some editing and checking steps that were resource consuming and led to the non inclusion of relevant information collected in the field.

Such a big program required a lot of efforts to be designed and organised in the field. To make the most of large epidemiological surveys, they should last for at least three years to produce results that give a tendency in time. The outcomes of EPILOBEE were an essential prerequisite to the implementation of future explanatory studies investigating the potential causes of honeybee colony losses such as multiple and co-exposure to pesticides (e.g. insecticides, fungicides and acaricides) and their possible interactions with infectious agents.

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1. Introduction

1.1. Background as provided by EFSA

In 2008, EFSA conducted a survey on existing bee surveillance systems in EU (EFSA 2008) and following its recommendations, the European Commission established an EU Reference Laboratory (EURL) for honeybee health (Commission Regulation (EU) No 87/2011) and funded an EU wide monitoring program on honeybee mortalities and diseases in Europe (EPILOBEE). This active epidemiological surveillance program was implemented in 17 EU Member States (MS), over 2 consecutive years (from autumn 2012 to summer 2014), following a harmonised protocol based on EURL guidelines.

The results of this program showed a geographic north-south trend in mortality (Chauzat, Laurent, et al. 2013), but given the large dataset, a high number of variables are not yet fully analysed, and the absence of data on the monitoring of other bee stressors (i.e. chemical and environmental factors), these results remain preliminary.

At EFSA, the Scientific Committee and Emerging Risks unit (SCER) initiated, in May 2012, horizontal work in the area of bee health through the establishment of an internal and multidisciplinary task force (i.e. the Bee Task Force) and through the organisation of a scientific colloquium (EFSA 2013). The Bee Task Force produced an inventory of EFSA's work in the area of bee health (EFSA 2012) and consulted a wide range of stakeholders (i.e. the European Commission and MS) to identify knowledge gaps in research and to make recommendations to move towards an integrated and holistic risk assessment of multiple stressors on bees (EFSA 2014).

To reach this goal, SCER adopted a strategy and a detailed program of activities in the area of bee health for the period 2014-2019. During this period, the SCER Unit, in collaboration with other relevant EFSA units and external experts, will gather and assess data/evidence to move towards a holistic approach to the risk assessment of multiple stressors on bees. Among these data, the EPILOBEE dataset was considered as an important piece of evidence that needed to be further considered by experts.

The data collected through the EPILOBEE program allows:

- the quantification of the mortality of honeybee colonies, in a harmonised way, in the 17 MS[1] which applied and complied with the EURL guideline. During the second year of the project, England and Wales left the program, therefore 16 MS participated to EPILOBEE.
- the assessment of disease prevalence and the inventory of information related to beekeeping practices to estimate the health of the bee populations.

These data were collected over two consecutive years (2012/2013 and 2013/2014). Bee mortality, farming practices and clinical manifestations of the main infectious and parasitic diseases[2] were recorded in questionnaires by bee inspectors at two periods:

- over winter (one visit before and one visit after winter);
- during the beekeeping season (one visit after summer).

[1] Belgium, Denmark, Germany, Estonia, Finland, France, Greece, Hungary, Italy, Latvia, Lithuania, Poland, Portugal, Slovakia, Spain, Sweden and the United Kingdom.

[2] The parasitic disease Varroosis caused by the *Varroa destructor* mites; the fungal disease Nosemosis caused by *Nosema* spp.; the viral paralysis caused by the chronic bee paralysis virus (CBPV); the two main brood diseases are the European foolbrood (EFB) and the American foolbrood (AFB) caused by the bacteria *Melissococcus plutonius* and *Paenibacillus* larvae, respectively; the exotic arthropods, the Small Hive Beetle (SHB) or *Aethina tumida*, and tropilaelaps mites.

Additionally, laboratory analyses were performed on samples collected during the visits.

The full methodology, including the protocol, the data collection and management, and the preliminary results obtained on bee mortality and diseases prevalence for the first year of the program are described by (Chauzat, Laurent, et al. 2013).

The aim of this procurement procedure is to conclude a direct contract for the execution of specific tasks over a clearly defined period as defined in these tender specifications.

The overall objective of this contract resulting from this negotiated procedure is to perform analyses on the full dataset of the two consecutive years (2012/2013 and 2013/2014)[3] to establish statistical associations between colony mortalities and some risk factors including diseases prevalence, use of veterinary treatments, the context of beekeeping and the apiary geographical repartition.

Between autumn 2012 and summer 2013, 31 664 colonies located in 3 053 apiaries were fully visited by around 2 000 bee inspectors. Overall, 9 159 visits of apiaries were implemented in EPILOBEE leading to 109 598 laboratory analysis. All these data were stored in a database (138 variables and as of July 2014: 360 000 lines of data). Some MS are still in the phase of sending final data from the fourth sampling period (i.e. the beekeeping season of the second year corresponding to the last visits conducted after summer 2014) and for the two consecutive years (2012-2014).

1.2. Terms of Reference as provided by EFSA

The overall objective of this contract resulting from this negotiated procedure is to perform analyses on the full dataset of the two consecutive years (2012/2013 and 2013/2014)[4] to establish statistical associations between colony mortalities and some risk factors including diseases prevalence, use of veterinary treatments, the context of beekeeping and the apiary geographical repartition.

The specific objectives for the contract are:

Objective 1: To describe the study design, the methodology, statistical tests (including modelling techniques, if any), data editing (deleting, correcting, editing for consistency, clearing mistakes, reporting 'checking rules', etc.) and the variables used for the two consecutive years (2012-2014).

Objective 2: To establish potential associations between colony mortalities and potential risk factors such as diseases prevalence, use of veterinary treatments, the context of beekeeping and the apiary geographical repartition in the 17 Member States and for the two consecutive years (2012-2014); the biological relevance of those associations need to be discussed in light with the current findings described in the scientific literature.

This contract was awarded by EFSA to:

Contractor : ANSES/EURL 14 rue Pierre et Marie Curie. 94701 Maisons-Alfort Cedex FRANCE

Contract title: EFSA call on the statistical analysis of EPILOBEE data

Contract/Grant number: NP/EFSA/SCER/2014/02

[3] Including four sampling periods: winter 2012/2013, spring/summer 2013, winter 2013/2014 and spring/summer 2014.
[4] Including six sampling periods: autumn 2012, spring 2013, summer 2013, autumn 2013, spring 2014 and summer 2014.

2. Data and Methodologies

Guidelines for a pilot surveillance project on honeybee colony losses were issued by the EURL for bee health (http://ec.europa.eu/food/archive/animal/liveanimals/bees/docs/annex_i_pilot_project_en.pdf). Subsequent amendments to the guidelines were issued prior to the beginning of the study.

2.1. Survey design

The EPILOBEE surveillance was designed to collect data on a representative number of apiaries and colonies in each MS through onsite investigations. The sampling frame was based on a two stage random sampling with apiaries as primary units and bee colonies as the secondary units enabling representativeness. The protocol is detailed in (Chauzat, Laurent, et al. 2013). The sampling frame consisted of beekeepers and apiaries that were randomly selected in each MS from a national list of beekeepers as complete as possible (see guidelines for more information in (EURL 2011). Within each apiary, the appropriate number of randomly selected colonies was calculated to be representative of the apiary. This number was calculated according to the probability of the detection of mortality and bee diseases (EURL 2011). The samples used in this study were the total number of sampled apiaries from each MS. There was no overall sample frame (all 17 MS together) used to select the apiaries. Despite the peculiarities of national protocols (sampling frames, list of apiaries, sample size, spatial representative), sampling was harmonised for the calculations (Garin et al. 2014). Data were recorded in a standardised way at the European level using an online database via a website developed by the EURL and the French epidemiological surveillance platform for Animal Health.

In 2013, an amendment to the guidelines (EURL 2013) recommended the following :

- at least one third of the total beekeepers sampled in the study are renewed. These beekeepers should be selected according to the same methodology as that described in the initial application (stratification of the population, random selection) of each MS.
- ABPV and DWV should not be monitored.
- CBPV should be monitoredstudied
- Nosema *spp*. typing must be performed only on colonies presenting clinical signs of Nosemosis

In the rest of the report, **EPILOBEE first year** will refer to the sampling work implemented from **autumn 2012 to summer 2013**, **EPILOBEE second year** will refert to sampling done **between autumn 2013 to summer 2014**.

England and Wales did not take part in EPILOBEE second year.

Three visits were set up in each MS for each selected apiary: before winter (autumn visit: V1), after winter (spring visit: V2) and during the beekeeping season (summer visit: V3). At each visit, each selected colony was examined and information collected on the status of the colonies which allowed the calculation of the winter and seasonal mortality rates. If colonies exhibited clinical signs of a disease, samples were collected for subsequent laboratory analyses. The main honeybee diseases clinically investigated in the frame of this program were those listed for notification or trade and import rules or for national eradication programs at the European level (European Commission 1992): the fungal disease Nosemosis, the parasitic disease varroosis, the two main diseases affecting brood the American foulbrood (AFB) and the European foulbrood (EFB) and a viral disease caused by the chronic bee paralysis virus (CBPV). An apiary was considered suffering from a disease, if the disease was diagnosed in one or more colony(ies). During autumn visits, all the selected colonies were systematically sampled to assess of the infestation by *V. destructor* mites.

Case definitions and samples to be collected were detailed in the protocol provided by the EURL and discussed with Member Statesduring several workshops. They are available upon request to the EURL.

Subsequently, each MS organised the trainings, managed the implementation of the visits and recorded the data in an online database at the national level.

For EPILOBEE second year, it was recommended to renew all the beekeepers for comparison purposes with the data from EPILOBEE first year. Taking into account the difficulty of beekeeper selection and involvement in such a detailed protocol, it was requested to renew at least one third of the total beekeepers sampled compared to the first year. The same methodology as the one implemented in the previous year was applied for the selection of the beekeepers, apiaries and colonies.

During EPILOBEE first year, 31 664 colonies were randomly selected in 3 053 apiaries (aslo randomly selected) visited at the three visits. From the randomly selected colonies, samples were collected to perform 109 598 analyses by around 1 200 bee inspectors. During EPILOBEE second year, 27 498 randomly selected colonies were located in 2 745 apiaries also visited three times Around 800 bee inspectors collected samples to perform 45 322 analysis (data extracted from 5th of March 2015). The EPILOBEE dataset comprises 527 506 lines of data and 138 variables.

Two mortality rates were calculated (the epidemiological unit being the apiary):

- **the winter mortality** calculated between V1 and V2, in order to quantify the colony losses that occurred during the winter.
- **the seasonal mortality** calculated between V2 and V3, in order to quantify the colony losses that occurred during the beekeeping season.

The results obtained on bee mortality and disease prevalence for the two years of the program are described in (Chauzat, Laurent, et al. 2013) and (Laurent et al. 2015).

Additional data was collected using questionnaire filled out by bee health inspectors, or under their supervision, at the time of sampling. This questionnaire can be found in Appendix A. The data is organised in three levels:

(1) Apiary level. For each apiary, information was collected on the beekeeper (BEEKEEPER_APIARY table), health events related to the apiary (HEALTH_EVENTS table), the treatments applied (TREATMENT table), the management operations (MANAGEMENT table), the migrations (MIGRATION table), the colonies selected and checked for this apiary (COLONY table) and the visits implemented (VISIT table).

(2) Colony level. For each colony (COLONY table), information was collected on the diseases suspected in this colony (DISEASE_SUSPECTED table), the symptoms observed in this colony during the visits (SYMPTOMS table), the samples collected in this colony during the visits (SAMPLE table) and the condition of this colony (STRENGTH table).

(3) Sample level. For a given sample (SAMPLE table), information on the laboratory was collected on analyses performed on these samples (RESULTS table).

The information from the questionnaires and the laboratory results was gathered in the 12 tables representing a total of 138 variables. A detailed entity relationship diagram of the EPILOBEE database can be found in Appendix B.

The data dictionary with the definitions for each of the 138 variables of the EPILOBEE survey can be found in Appendix C1.

2.2. Data validation and cleaning

Data collected during the two years through field questionnaires and laboratory results were recorded in a European online database. Each MS had registered access to the database and was responsible for entering the data from the questionnaires. Training on the database operation was provided to the

MSs. Each MS was in charge of training staff at the national level to use the database. A user manual was provided to the MSs. Two MS (Belgium and Spain) did not use the online database to enter the data which were sent in separate files. Belgium used the online database during the second year of EPILOBEE.

A back-and-forth system was set up between the EURL and the MS for the correction of data related to colony mortality and disease prevalence. Discrepancies were checked by the EURL and corrections were made by the MS if needed.

The EPILOBEE survey has been designed to quantify the honeybee colony mortality. Only the apiaries with consistent data related to the mortality were taken into account. In addition, only the apiaries fully visited during the entire year of the project were taken into account (i.e. three visits for a given apiary: autumn, spring and summer).

In order to identify apiaries with consistent data, several data validation steps were applied to the dataset, a summary is presented in the Tables 1 to 5 (details are available in Appendix D).

EPILOBEE *first* year

3 053 apiaries were visited 3 times during EPILOBEE first year. Subsequently to the checks and edits **2 332 apiaries were kept** for the calculation of colony mortality (Table 1).

Table 1: Checks and edits applied to the data from EPILOBEE *first* year

Check / edit	Number of apiaries before the checks / edits	Number of apiaries removed	Number of apiaries with edits
Check #A: Data from Portugal	3 053	109	-
Check #1: Missing entries for the number of colonies randomly selected at V1	2 944	0	-
Check #2: Consistency between two variables referring to the number of colonies randomly selected at V1	2 944	23	-
Check #3 – check #4: Missing entries for the number of living colonies at V2 and at V3	2 921	20	-
Edit #1: Correction of the number of sold colonies between V1 and V2	2 901	-	4
Edit #2: Correction of the number of sold colonies between V2 and V3	2 901	-	4
Edit #3: Correction of the number of dead colonies between V1 and V2	2 901	-	0
Edit #4: Correction of the number of dead colonies between V2 and V3	2 901	-	0
Check #5 – check #6: Missing entries for the number of dead colonies between V1 and V2 and between V2 and V3	2 901	1	-
Check #7:Consistency between the number of colonies randomly selected at V1 and information reported at V2	2 900	32	-
Check #8: Consistency between the number of living colonies at V2 and information reported at V3	2 868	392	-
Check #9:The value zero entered for the size of the apiary	2 476	1	-
Check #10: Consistency between the number of colonies randomly selected at V1 and the size of the apiary	2 475	14	-
Check #11:Consistency between the number of colonies owned by the beekeeper and the size of the apiary, in case of one apiary	2 461	2	-
Check #12: Consistency between the number of colonies owned by the beekeeper and the size of the apiary, in case of more than one apiary	2 459	127	-
FINAL NUMBER	**2 332**		

A substantial number of apiaries were removed subsequently to the check #8 (Table 1). This check verifies that the number of selected colonies present in the apiary during the summer visit was consistent with the number of selected colonies still alive at the previous visit. The apiaries removed were distributed in all the MS without any preponderance of one MS over the others (Table 2).

Table 2: Distribution of the 392 apiaries removed subsequently to the check #8 (for EPILOBEE *first* year)

MS	Number of apiaries before the check #8	Number of apiaries removed	Percentage of apiaries removed (%)
Belgium	145	1	0.7
Denmark	150	51	34.0
England and Wales	188	20	10.6
Estonia	193	29	15.0
Finland	148	11	7.4
France	257	36	14.0
Germany	216	28	13.0
Greece	143	4	2.8
Hungary	176	7	4.01
Italy	173	31	17.9
Latvia	184	94	51.1
Lithuania	189	9	4.8
Poland	189	11	5.8
Portugal	0	0	0.0
Slovakia	189	7	3.7
Spain	188	12	6.4
Sweden	140	41	29.3
TOTAL	**2 868**	**392**	**-**

Finaly, subsequently to all checks and edits, 721 apiaries were removed from the data set (Table 3). All apiaries from Portugal were removed (see Appendix D) and a part of the apiaries located in Latvia, and Danmark (57.1% and 44.8%, respectively).

Table 3: Distribution of the 721 apiaries removed after checks and edits. The number of apiaries are expressed in number and in percentage of the total number of apiaries visited three times during EPILOBEE *first* year.

MS	Number of apiaries before the checks	Number of apiaries removed	Percentage of apiaries removed (%)
Belgium	145	10	6.9
Denmark	174	78	44.8
England and Wales	188	27	14.4
Estonia	193	33	17.1
Finland	148	12	8.1
France	295	92	31.1
Germany	216	36	16.6
Greece	143	4	2.8
Hungary	176	12	6.8
Italy	178	43	24.1
Latvia	189	108	57.1
Lithuania	191	70	36.6
Poland	190	26	13.7
Portugal	109	109	100.0
Slovakia	190	8	4.2
Spain	188	12	6.4
Sweden	140	41	29.3
TOTAL	**3 053**	**721**	**-**

EPILOBEE *second* year

2 745 apiaries were visited 3 times during EPILOBEE second year. Subsequently to the checks and edits, **2 426 apiaries were kept** for the calculation of colony mortality (Table 4).

Table 4: Checks and edits applied to the data from EPILOBEE *second* year

Check / edit	Number of apiaries before the checks / edits	Number of apiaries removed	Number of apiaries with edits
Check #A: Data from Portugal	2 745	130	-
Check #1: Missing entries for the number of colonies randomly selected at V1	2 615	15	-
Check #2: Consistency between two variables referring to the number of colonies randomly selected at V1	2 600	10	-
Check #3 – check #4: Missing entries for the number of living colonies at V2 and at V3	2 590	2	-
Edit #1: Correction of the number of sold colonies between V1 and V2	2 588	-	209
Edit #2: Correction of the number of sold colonies between V2 and V3	2 588	-	191
Edit #3: Correction of the number of dead colonies between V1 and V2 for Finland	2 588	-	96
Edit #3': Correction of the number of dead colonies between V1 and V2for all MS except Finland	2 588	-	21
Edit #4: M Correction of the number of dead colonies between V2 and V3 for Finland	2 588	-	142
Edit #4': Correction of the number of dead colonies between V2 and V3 for all MS except Finland	2 588	-	25
Check #5 – check #6: Missing entries for the number of dead colonies between V1 and V2 and between V2 and V3	2 588	1	-
Check #7:Consistency between the number of colonies randomly selected at V1 and information reported at V2	2 587	41	-
Check #8: Consistency between the number of living colonies at V2 and information reported at V3	2 546	29	-
Check #B: Missing entries for the size of the apiary	2 517	12	-
Check #9:The value zero entered for the size of the apiary	2 505	0	-
Check #10: Consistency between the number of colonies randomly selected at V1 and the size of the apiary	2 505	0	-
Check #11:Consistency between the number of colonies owned by the beekeeper and the size of the apiary, in case of one apiary	2 525	56	-
Check #12: Consistency between the number of colonies owned by the beekeeper and the size of the apiary, in case of more than one apiary	2 449	23	-
FINAL NUMBER	**2 426**		

The edit #1 and the edit #2 were applied to a substantial number of apiaries (respectively 209 and 191) allowing to keep as much data as possible in the analysis (Table 4). The number of apiaries removed from the data set subsequently to the check #7 and the check #8 was much lower compared to EPILOBEE first year.

Subsequently to the checks and edits, 319 apiaries were removed from the data set (Table 5). Most of apiaries were located in Latvia, France, Germany and Italy (23.6%, 16.8%, 15.4% and 15.2%

respectively) with the exception of Portugal (all the apiaries were removed from the statistical analysis.

Table 5: Distribution of the 319 apiaries removed after checks and edits. The number of apiaries are expressed in number and in percentage of the total number of apiaries visited three times during EPILOBEE *second* year.

MS	Number of apiaries before the checks	Number of apiaries removed	Percentage of apiaries removed (%)
Belgium	141	2	1.4
Denmark	176	7	4.0
Estonia	195	0	0.0
Finland	155	0	0.0
France	321	54	16.8
Germany	207	32	15.4
Greece	37	2	5.4
Hungary	184	1	0.5
Italy	145	22	15.2
Latvia	186	44	23.6
Lithuania	162	3	1.8
Poland	189	0	0.0
Portugal	130	130	100.0
Slovakia	198	17	8.6
Spain	185	0	0.0
Sweden	134	5	3.7
TOTAL	**2 745**	**319**	**-**

2.3. Analysis of factors related to honey bee colony mortality

2.3.1. Definition of the response variables

The analyses were performed for two different response variables: Winter mortality and Seasonal mortality. The case definitions were agreed between the EURL and the MS at the kick off meeting in Brussels in 2012.

A colony was considered suffering from **winter mortality** if:

- during V1 (before the wintering period), the colony was recorded alive by the bee inspector and was previously estimated capable of overwintering by the beekeeper.
- during V2 (after the wintering period):
  - the colony hosted some honeybees but was considered non-viable (nearly dead = less than 500 honeybees in the colony) and could not start again for the beekeeping season, according the bee inspector expertise;
  - OR the colony was in one of the following situations: all the honeybees were dead within the hive; all the honeybees were dead and the hive was empty; the colony hosted laying workers with no queen.

In order to assess the winter mortality rate, the visit after the wintering period should be performed early enough, before the typical increase of honeybee population during the spring. The date should be adapted to the meteorological conditions in the surveyed area.

A colony was considered suffering from **seasonal mortality** if:

- during V2 (after the wintering period), the colony was recorded alive by the bee inspector and was previously estimated capable of survive the season by the beekeeper.

- during V3 (during the beekeeping season):

the colony hosted some honeybees but was considered non-viable (nearly dead = less than 500 honeybees in the colony) and could not continue the beekeeping season, according the bee inspector expertise;

- OR the colony had one of the following clinical signs: all the honeybees were dead within the hive; all the honeybees were dead and the hive was empty; the colony hosted laying workers with no queen;
- OR the colony was merged with another between visit 2 and visit 3.

The calculation of the mortality rates were as follow:

$$\text{winter mortality} = \frac{dead\_v1\_v2}{alive\_v2 + dead\ v1\_v2}$$

$$\text{seasonal mortality} = \frac{dead\_v2\_v3}{alive\_v3 + dead\_v2\_v3}$$

with:

dead_v1_v2 = number of dead colonies between the autumn and spring visits
alive_v2 = number of colonies still alive during the spring visit (v2)
dead_v2_v3 = number of dead colonies between the spring visit and summer visits
alive_v3 = number of colonies still alive during the summer visit (v3)

2.3.2. Selection of the explanory variables to be included in the statistical analysis

The number of variables was too large to be included in the statistical analysis. Four criteria were used to select the ones to be investigated:

Expert opinion: the variable was considered significant to explain mortality

Completeness: a variable with a high percentage of missing data was not included in the analysis (missing data (NA) above 20% for the first year and above 30% for the second year)

Format: data stored in free fields were not included in the analysis due to the difficulties to use the information

To facilitate the implementation, interpretation and feasibility of statistical models, some variables were redefined by collapsing some of the original categories into new ones. The different criteria were described and results presented in Appendix E. In total, **36 explanatory variables** were kept for the statistical analysis (Table 6).

The explanatory variables taken into account were not the same if either the winter mortality or the seasonal mortality were considered as response variables. The Table 6 lists all the explanatory variables without any distinction. Please refer to the Appendices H1 and H2 (column called EPILOBEE

first year) for the lists of the explanatory variables taken into account in the analysis of risk factors affecting the winter mortality or affecting the seasonal mortality respectively.

The distribution of the apiaries for the different variables kept for the statistical analysis were included in Appendix G.

Table 6: Definition and content of each variable kept in the statistical analysis

Variables	Definition	Categories
Age	Age of the beekeeper.	Less than 30
		30-45
		45-65
		Over 65
Activity	Activity of the beekeeper.	Hobby
		Part-time
		Professional
Beekeep_for	Experience of the beekeeper in beekeeping.	Less than 2 years
		2-5 years
		More than 5 years
Qualif	Did the beekeeper have any formal qualification in beekeeping?	Yes
		No
Training	Has the beekeeper attended any beekeeping and/or bee health training in the last 3 years?	Yes
		No
Coop_treat	Was the beekeeper part of a cooperative treatment against varroa with neighboring beekeepers?	Yes
		No
Bee_population_size	Total number of colonies owned by the beekeeper.	Less than 51 colonies
		51 - 100
		101 - 150
		151 - 200
		201 - 300
		More than 300 colonies
Country	Country where the apiary was located.	BELGIUM
		DENMARK
		ENGLAND AND WALES
		ESTONIA
		FINLAND
		FRANCE
		GERMANY
		GREECE
		HUNGARY
		ITALY
		LATVIA
		LITHUANIA
		POLAND
		PORTUGAL
		SLOVAKIA
		SPAIN
		SWEDEN
Apiary_size	Total number of colonies in the apiary randomly selected.	Less than 5 colonies
		6 - 10
		11 - 20
		21 - 50
		More than 50 colonies
Production	Production targeted by the beekeeper.	Only honey
		Includes pollen production
		Includes pollination services
		Includes queens production
		Includes royal jelly production
		Includes swarm production
		Other

Variables	Definition	Categories
Apiarist_book	Had the beekeeper an apiarist book?	Yes
		No
Org_member	Was the beekeeper member of a regional / national beekeeping organisation ?	Yes
		No
Continue	Did the beekeeper plan to continue his / her bee activity for more than 2 years?	Yes
		No
Breed	Which was the honeybee strains/subspecies of honeybees in the apiary?	A. m. carnica
		A. m. ccm[5]
		A. m. iberiensis
		A. m. ligustica
		A. m. mellifera
		Buckfast
		Hybrid
		Local bees
Chronic_Depop	Did the apiary experience any chronic depopulation before the first visit of the EPILOBEE program?	Yes
		No
ClinSign_Brood	Did the apiary experience any clinical signs on brood before the first visit of EPILOBEE program?	Yes
		No
ClinSign_Honeybees	Did the apiary experience any clinical signs on honeybees before the first visit of EPILOBEE program?	Yes
		No
H_rate_ColMortality	Did the apiary experience any hight rate of colony mortality (> 10 %) before the first visit of EPILOBEE program?	Yes
		No
H_rate_HoneyMortality	Did the apiary experience any hight rate of honey mortality before the first visit of EPILOBEE program?	Yes
		No
OtherEvent	Did the apiary experience any other event before the first visit of EPILOBEE program?	Yes
		No
VarroaMites	Did the apiary experience any varroa mites on adult honeybees before the first visit of EPILOBEE program?	Yes
		No
Queen Problems	Did the apiary experience any problems with queen before the first visit of EPILOBEE program?	Yes
		No
Management	Main management objective of the beekeeper.	Livestosck
		Production
		Health Conditions
		Livestock + Production
		Livestock + Health Conditions
		Production + Health Conditions
		Production + Livestock + Health Conditions
		No Infromation
Swarm_bought	Number of swarm(s) bought by the beekeeper.	None
		1 swarm
		2 - 5 swarms
		More than 5 swarms
		No information
Swarm_produced	Number of swarm(s) produced by the beekeeper.	None
		1 - 5 swarm(s)
		6 - 10 swarms
		More than 10 swarms
		No information
Queen_bought	Number of queens(s) bought by the beekeeper.	None
		1 - 5 queen(s)
		6 - 10 queens
		More than 10 queens
		No information

[5] Synthetic category, please refer to the Appendix C2, for details.

Variables	Definition	Categories
Queen_produced	Number of queen(s) produced by the beekeeper.	None
		1 - 5 queen(s)
		6 - 10 queens
		More than 10 queens
		No information
MidSeason_Target	What kind of nectar flow was targeted by the beekeeper during the past seasonal period?	Crops
		WildFlowers
		Other
		Diverse[6]
		No information
Environment	What kind of environment surrounded the apiary?	Farmland
		Flora
		Orchards
		Town
		Wood
		Diverse[7]
		None
AmericanFoulbroodV1	Was there at least one colony suffering from American foulbrood at autumn visit (V1) in the apiary?	Not Suffering
		Suffering
AmericanFoulbroodV2	Was there at least one colony suffering from American foulbrood at spring visit (V2) in the apiary?	Not Suffering
		Suffering
EuropeanFoulbroodV1	Was there at least one colony suffering from European foulbrood at autumn visit (V1) in the apiary?	Not Suffering
		Suffering
EuropeanFoulbroodV2	Was there at least one colony suffering from European foulbrood at spring visit (V2) in the apiary?	Not Suffering
		Suffering
VarroosisV1	Was there at least one colony suffering from Varroosis at autumn visit (V1) in the apiary?	Not Suffering
		Suffering
VarroosisV2	Was there at least one colony suffering from Varrosis at spring visit (V2) in the apiary?	Not Suffering
		Suffering
NosemosisV1	Was there at least one colony suffering from Nosemosis at autumn visit (V1) in the apiary?	Not Suffering
		Suffering
NosemosisV2	Was there at least one colony suffering from Nosemosis at spring visit (V2) in the apiary?	Not Suffering
		Suffering
ChronicParalysisV1	Was there at least one colony suffering from Chronic paralysis at autumn visit (V1) in the apiary?	Not Suffering
		Suffering
ChronicParalysisV2	Was there at least one colony suffering from Chronic paralysis at spring visit (V2) in the apiary?	Not Suffering
		Suffering
Migration	Did the apiary migrate at least one time during the past seasonal period , before the winter period of after the winter period?	Yes
		No
Merger	Was there at least one colony merged in the apiary between the autumn visit and spring visit, the spring visit and summer visit?	Yes
		No
Winter mortality class	In which category did the colony winter mortality rate stand?	No mortality
		0 - 5 %
		6 - 10 %
		11 - 20 %
		21 - 50 %
		More than 51 %
First_Second	Did the apiary participate to EPILOBEE first year or is it a new apiary selected for EPILOBEE second year?	Second participation
		New apiary
Program	Did the apiary take part to EPILOBEE first year or to EPILOBEE second year?	First year
		Second year

[6] Synthetic category, please refer to the appendix C3, for details.
[7] Synthetic category, please refer to the appendix C3, for details.

2.4. Methodologies

2.4.1. Specific methodology to process the EPILOBEE data

The information related to dates and disease, the management of apiaries and the colony migration were specifically treated to be used for the statistical analysis (Appendix F1). In some cases, the information contained in tables was not at the apiary level and were specifically reported at this level (Appendix F2). In many cases the data entries were heterogeneous due to different ways to report the information (i.e. "less than 30" or "<30; or different languages used). All cleansing scripts were developed with R software (Appendices C2 and C3). The following continuous variables were transformed into categorical variables for the statistical analysis (Appendix C2):

- *Bee_population_size*
- *Apiary_Size*
- *Swarm_bought*
- *Swarm produced*
- *Queen_bought*
- *Queen_produced*
- *Winter_mortality_class*

To reduce the number of categories of some variables, the information was grouped into new categories for the followings:

- *Management*
- *MidSeason_Target*
- *Production*
- *Breed*
- *Environment*

Table 7: New categories for *Management*

Information stored in the database	New categories
Increase the production	Production
Increase the livestock	Livestock
Maintain the livestock	
Maintain the livestock and increase the livestock	
Improve the health condition	Health Conditions

Table 8: New categories for *MidSeason_Target*

Information stored in the database	New categories
Beans	Crops
Colza	
Lavander	
Lime	
Orange	

Orchards	
Rapeseed	
Raspberry	
Sunflower	
Acacia	Wildflowers
Chesnutree	
Clover	
Eucalyptus	
Heather	
Multiflower	
Rosmarinus	
Thymus	
Honeydew	Other
Other	

If a given apiary targeted two or three different environments, the category "Diverse" was reported.

Due to the great number of combinations, beekeeper production was grouped according to the following rational:

- The combination with "honey" production and any other production was grouped under the name 'Includes *the other* production' (with the exception of "Pollination Services + Honey")
- Any combination with "Pollination services" was grouped under "Pollinations services" due to the high risk of pesticide exposure during pollination services
- All the combinations without "Pollination services" were grouped under "Other".

Table 9: New categories for *Production*

Information stored in the database	New categories
Honey	Only honey
Pollen	Includes pollen production
Honey + Pollen	
Pollination Services	Includes pollination services
Honey + Pollination Services	
Honey + Pollen + Pollination Services	
Honey + Queens + Pollination Services	
Honey + Swarms + Pollination Services	
Honey + Pollen + Queens + Pollination Services	
Honey + Pollen + Swarms + Pollination Services	
Honey + Queens + Swarms + Pollination Services	
Honey + Pollen + Royal jelly + Queens + Swarms + Pollination Services	
Queens	Includes queen production
Honey + Queens	
Royal jelly	Includes royal jelly production
Honey + Royal jelly	
Swarms	Includes swarm production
Honey + Swarms	
Queens + Swarms	Other
Honey + Pollen + Queens	
Honey + Pollen + Royal jelly	
Honey + Pollen + Swarms	
Honey + Queens + Swarms	
Honey + Queens + Royal jelly	

Honey + Swarms + Royal jelly	
Honey + Pollen + Royal jelly + Queens	
Honey + Pollen + Swarms + Queens	
Honey + Pollen + Swarms + Royal jelly	
Honey + Queens + Swarms + Royal jelly	
Honey + Pollen + Queens + Swarms + Royal jelly	

Breed

The subspecies *A. m. carpatica*, *A. m. caucasica* and *A. m. macedonia* were pooled into one category called *A. m. ccm* for EPILOBEE first year (Table 10) and second year (Table 11). The beekeeper could chose the category local bees in the questionnaire.

Table 10: Categories of the *Breed* variable for EPILOBEE *first* year

Initial categories		Synthetic categories	
Categories	Number of apiaries	Categories	Number of apiaries
A. m. carnica	705	*A. m. carnica*	705
A. m. carpatica	5	*A. m. ccm*	51
A. m. caucasica	6		
A. m. macedonica	40		
A. m. iberiensis	67	*A. m. iberiensis*	67
A. m. ligustica	229	*A. m. ligustica*	229
A. m. mellifera	210	*A. m. mellifera*	210
Buckfast	232	Buckfast	232
Hybrid	395	Hybrid	395
Local bees	226	Local bees	226
NA	217	NA	217
TOTAL	**2 332**	TOTAL	**2 332**

Table 11: Categories of the *Breed* variable for EPILOBEE *second* year

Initial categories		Synthetic categories	
Categories	Number of apiaries	Categories	Number of apiaries
A. m. carnica	835	*A. m. carnica*	835
A. m. carpatica	9	*A. m. ccm*	35
A. m. caucasica	18		
A. m. macedonica	8		
A. m. iberiensis	72	*A. m. iberiensis*	72
A. m. ligustica	262	*A. m. ligustica*	262
A. m. mellifera	145	*A. m. mellifera*	145
Buckfast	345	Buckfast	345
Hybrid	218	Hybrid	218
Local bees	340	Local bees	340
NA	174	NA	174
TOTAL	**2 426**	TOTAL	**2 426**

Environment

The 6 variables concerning the apiary environment (*Farmland*, *Floral*, *Orchards*, *Town*, *Industries* and *Wood*) were grouped into a new one.

For a given apiary, if at least two kinds of environment were recorded, the category "Diverse" was reported.

The distribution of the numbers in all categories was assessed. Several categories were gathered into a new synthetic one, and in the case of small numbers into one category.

A synthetic category was created (Town and Industries) to bring together the Town and Industries categories for EPILOBEE first year (Table 12) and second year (Table 13) for the environment surrounding the apiaries.

Table 12: Categories of the *Environment* variable for EPILOBEE *first* year

Initial categories		Synthetic categories	
Categories	Number of apiaries	Categories	Number of apiaries
Diverse	1830	Diverse	1830
Farmland	96	Farmland	96
Flora	95	Flora	95
None	13	None	13
Orchards	29	Orchards	29
Town	32	Town and Industries	35
Industries	3		
Wood	42	Wood	42
NA	192	NA	192
TOTAL	**2 332**	TOTAL	**2 332**

Table 13: Categories of the *Environment* variable for EPILOBEE *second* year

Initial categories		Synthetic categories	
Categories	Number of apiaries	Categories	Number of apiaries
Diverse	1799	Diverse	1799
Farmland	40	Farmland	40
Flora	49	Flora	49
None	14	None	14
Orchards	16	Orchards	16
Town	20	Town and Industries	21
Industries	1		
Wood	19	Wood	19
NA	468	NA	468
TOTAL	**2 426**	TOTAL	**2 426**

2.4.2. The statistical methodology

Aim and steps

The aim of the statistical analysis was to establish potential associations between colony mortalities and potential risk factors (the selected variables considered as explanatory) for the two consecutive years (2012-2014). The explanatory variables could be structural (e.g., country, beekeeper age, size of the apiary, size of the beekeeping operations), related to the apiary management (e.g., production, health conditions, livestock), apiary migration, environment, diseases (e.g., AFB, EFB, CBPV, nosemosis) or apiary health (e.g., chronic depopulation, clinical signs in brood).

The two years under study being dissimilar, years were firstly studied separately. Thereafter, an overall study including all the years was conducted.

The epidemiological units being the apiaries, the two dependent variables (i.e. winter and seasonal honeybee colony mortalities) were considered as count numbers with quasi-Poisson distributions. In the following, the models used were the quasi-Poisson generalised linear models, also known as log-linear model.

Study for each year of EPILOBEE

For a specific year of EPILOBEE, only univariate models (i.e. models which associated each explanatory variables with each dependant ones) were performed. They aimed at interpreting the relationships between each explanatory variable and each of the two mortalities under study by means of quasi-Poisson generalised linear models.

The calculation of a p-value was performed for each explanatory variable, four times: for the winter mortality and the seasonal mortality of EPILOBEE first year, and for the winter mortality and the seasonal mortality of EPILOBEE second year. In this study, the p-value was associated to the likelihood ratio (LR) statistic, which followed Chi^2 distribution. In order to distinguish variable which had an statistically significant effect on a mortality studied, a 0.05 threshold was used: variables with a p-value inferior to this threshold had an statistically significant effect, while the ones with a p-value superior to this threshold did not have any statistically significant effect on the mortality studied. These models were performed using the glm function from the stats R package with a log link in a quasi-Poisson family.

For all these explanatory variables, contrasts were used to compare each mortality rate (of each category) of the explanatory variable to each of the other ones. In addition, each mortality rate (of each category) of the explanatory variable was compared to the empirical threshold of 10 % for the winter mortality. As there is no empirical threshold for the seasonal mortality, each mortality rate (for each category) of the explanatory variable was compared to the European mean, for the seasonal mortality.

Overall study

The overall study took into account the two years of the study with a complex statistical approach.

Step 1: Missing data imputation

In order to analyse a complete dataset, missing data were handled by means of an imputation method based on exploratory multivariate analysis (Josse et al. 2012). This imputation method came from an iterative algorithm based on scores and loadings from multivariate analysis respectively related to similarities between individuals and relationships between variables. As the explanatory variables to be imputed were all categorical, the multivariate analysis used was the multiple correspondence analysis (MCA). The imputation method was performed using the functions estim_ncpMCA (estimation of the number of dimensions used in the next reconstruction formula) and imputeMCA (imputing data using the number of dimensions previously calculated) from the missMDA R package (http://cran.r-project.org/web/packages/missMDA/index.html). As relationships between variables were year-dependant, missing data imputation was performed separately for each year of EPILOBEE. After imputation, the datasets from the first and second years of EPILOBEE were merged and this new and complete dataset was used in the subsequent steps.

Step 2: Selection of the explanatory variables mainly related to mortalities

In order to eliminate explanatory variables which definitely will not have a great influence into the models, a calculation of p-values (associated to the LR statistic) was performed for each explanatory variable, two times: for the winter mortality and for the seasonal mortality. A 0.20 threshold was used: variables with a p-value superior to this threshold were eliminated from the study, while the ones with a p-value inferior to the threshold were selected for the rest of the study.

These models were performed using the glm function from the stats R package with a log link in a quasi-Poisson family. Only the selected variables from step 2 were included in step 3.

Step 3: Summary of explanatory variables within a homogeneous thematic

In order to avoid quasi-collinearity within explanatory variables, variables were summarized through five homogeneous thematics previously defined (variables related to diseases, management, health events, beekeeper background, size). This was achieved by means of a Multiple Correspondence Analysis followed by a Hierarchical Clustering of observations on the main principal components (Greenacre 1984). These methods were performed using the MCA and HCPC functions from the FactoMineR R package (http://cran.r-project.org/web/packages/FactoMineR/index.html). The optimal number of clusters was chosen in accordance with the loss of inertia index, the cluster sizes and the cluster interpretability. In the following steps, summarised variables were used instead of the original ones.

Step 4: Elaboration of a new synthetic variable

As generalised linear models may be affected by quasi-collinearity between explanatory variables, correlations between these latter variables were additionally controlled by means of chi square tests. The five new summarised variables were still correlated with each other, all the new summarised variables were included in a MCA followed by a Hierarchical Clustering of observations on the main principal components as previously explained in step 3. The clustering result was considered as the new explanatory variable to be included in the multivariate model.

Step 5: Multivariate regression models

Finally and for the two mortalities to be explained, this new explanatory variable (obtained from step 4) was included as a fixed effect in mixed mutivariatePoisson regression models, the country and the year effects being considered as random effects in the analysis. The clusters of the new explanatory variable acted as categories. The two models were performed using the glmer function from the lme4 R package with a log link (http://cran.r-project.org/web/packages/lme4/index.html). Similarly to the study conducted for each year of EPILOBEE, contrasts were used to compare each cluster of the selected explanatory variable to the other ones.

3. Results

3.1. Study for each year of EPILOBEE

3.1.1. Preliminary results of the statistical analysis

The percentage of data completeness

It was necessary that each variable had a high percentage of completeness to be included in the analysis. Following the selection process (Criterion #2), the lowest percentage amongst the 36 variables kept in the analysis was 80% during EPILOBEE first year (*Training* variable) and 70% during EPILOBEE second year (*Apiarist_book* variable) (Table 14).

Table 14: Data completeness for each variable selected for the statistical analysis

Variables	EPILOBEE *first* year		EPILOBEE *second* year	
	Records without any NA	Percentage	Records without any NA	Percentage
Age	2 094	90	1 993	82
Activity	2 296	98	2 292	95
Beekeep_for	2 081	89	1 968	81
Qualif	2 002	86	1 826	75

Variables	EPILOBEE *first* year		EPILOBEE *second* year	
	Records without any NA	Percentage	Records without any NA	Percentage
Training	1 864	80	1 823	75
Coop_treat	2 017	87	1 771	73
Bee_population_size	2 332	100	2 426	100
Country	2 332	100	2 426	100
Apiary_Size	2 332	100	2 426	100
Production	2 210	95	2 079	86
Apiarist book	1 905	82	1 707	70
Org_member	2 100	90	1 986	82
Continue	2 052	88	1 900	79
Breed	2 115	90	2 252	93
Chronic_Depop	2 120	91	2 338	96
ClinSign_Brood	2 121	91	2 338	96
ClinSign_Honeybees	2 121	91	2 339	96
H_rate_ColMortality	2 129	91	2 344	96
H_rate_HoneyMortality	2 123	91	2 339	96
Other_Event	2 120	91	2 338	96
VarroaMites	2 126	91	2 339	96
QueenProblems	2 120	91	2 339	96
Management	2 071	89	2 344	96
Swarm_bought	2 332	100	2 426	100
Swarm_produced	2 332	100	2 426	100
Queen_bought	2 332	100	2 426	100
Queen_produced	2 332	100	2 426	100
MidSeason_Target	2 324	99	2 418	99
Environment	2 140	92	1 958	81
AmericanFoulbroodV1	2 332	100	2 426	100
AmericanFoulbroodV2	2 332	100	2 426	100
EuropeanFoulbroodV1	2 332	100	2 426	100
EuropeanFoulbroodV2	2 332	100	2 426	100
VarroosisV1	2 332	100	2 426	100
VarroosisV2	2 332	100	2 426	100
NosemosisV1	2 332	100	2 426	100
NosemosisV2	2 332	100	2 426	100
ChronicParalysisV1	2 332	100	2 426	100
ChronicParalysisV2	2 332	100	2 426	100
Migration	2 332	100	2 212	100
Merger	2 330	99	2 426	91
Winter_mortality_class	2 332	100	2 426	100
First_Second	-	-	2 426	100

European mean mortality

European mean winter and seasonal mortalities were calculated for each year of EPILOBEE and for each variable selected for the statistical analysis.

Variables with 100% of data completeness

For all the variables with 100% of data completeness, the European mean mortality rates were calculated taking into account all the apiaries selected for the statistical analysis (e.g. 2332 for the first year, 2426 for the second year). The means were weighted by the number of apiaries included in each category.The European means were calculated to be used as reference values for comparison later in the statistical analysis. The rates were lower during EPILOBEE second year compared to the first year for both mortalities (Table 15).

Table 15: European mean mortality for variables with 100% of data completeness

Mortalities	**EPILOBEE *first* year (%)**	**EPILOBEE *second* year (%)**
Winter mortality	15.00	8.03
Seasonal mortality	4.12	3.19

Variables with a percentage of data completeness inferior to 100%

When the percentage of data completeness was inferior to 100%, the European mortality means were different from those previously calculated (Table 15), due to the different number of apiaries taken into account (inferior to 2 332 for EPILOBEE first year and inferior to 2 426 for the second year). For the rest of the report, when the European mortality means were different from those (Table 15), the appropriate means were provided in the text or in the graphs (Appendix I).

Variables having a statistically significant effect on mortality

The effect of each variable on the winter and on the seasonal mortality was statistically checked (threshold 0.05 - Appendices H1 and H2). For a given variable, the p-value was calculated on a specific dataset composed of records without any NA. The dataset to explore the effect of the *Country* variable on the mortality included the data from Portugal (refer to Appendix D - special check A). As a consequence this specific dataset was composed of 2 437 apiaires for the first year and 2 553 apiaries for the second year.

Winter mortality

Twenty two variables had a statistically significant effect (p-value < 0.05) on the winter mortality during EPILOBEE first year and 17 during the second year.

The following variables had a statistically significant effect on the winter mortality during the first and second years of EPILOBEE (Appendix H1).

- The *Country* variable - the strongest effect
- The size of the apiary and of the operation *(Bee_population_size*) - the effect was higher for the size of the apiary
- For a given apiary, a high rate of colony mortality reported before EPILOBEE (*H-rate_ColMortality*) or clinical signs observed by the beekeeper on honeybees (*ClinSign_Honeybees*) before starting the program
- The operations of management implemented by the beekeeper (*Management*). The number of swarms bought, queens produced and the fact that the beekeeper merged the colonies or not also statistically influenced the winter mortality
- The typology of the beekeeper (hobby or professional activity = *Activity*)
- The honeybee breed
- The presence of American Foulbrood in the apiary at the autumn visit
- The objective of the production of the beekeeper (honey, swarms, Royal jelly …)

The effect of most of the variables listed above on the winter mortality was stronger during EPILOBEE first year compared to the second year.

The age of the beekeeper, the migration and the environment targeted, the environment surrounding the apiary, the number of queens bought by the beekeeper and the presence of Varroosis in the apiary at the autumn visit had also a statistically significant effect on the winter mortality, but only during EPILOBEE first year. Whether the beekeeper attended a training during the last 3 years or not,

the varroa mites observed on honeybees before EPILOBEE and clinical signs observed by the beekeeper on brood before the beginning of EPILOBEE had a statistically significant effect on the winter mortality during EPILOBEE second year.

Seasonal mortality

Eighteen variables had a statistically significant effect on the seasonal mortality during EPILOBEE first year, and 19 during EPILOBEE second year.

The following variables had a statistically significant effect on the seasonal mortality during the first and second years of EPILOBEE (Appendix H2)

- The *Country* variable had the strongest effect (similarly to the winter mortality)
- The previous winter mortality (*Winter_mortality_class*)
- Diverse health events having occured before the start of the EPILOBEE program such as clinical signs in brood or in honeybees, chronic depopulation, hight rate of colony mortality, hight rate of honeybee mortality or queen problems
- The management of operations: the number of swarms bought and queens produced and the fact that the beekeeper merged the colonies or not.
- The honeybee breed
- The presence of American Foulbrood and European Foulbrood in the apiary at the spring visit

Being part of a cooperative treatment against varroa (*Coop_treat*) and other operations management (number of swarms produced and queens bought) also had a statistically significant feffect on the seasonal mortality, but only during EPILOBEE first year. The size of the apiary, the operation size (*Bee_population_size*), the migration and the prescence of Varoosis in the apiary at the spring visit were statistically significant on the seasonal mortality only during EPILOBEE second year.

3.1.2. Statistical analysis for each year of EPILOBEE

The effects of the different variables were analysed through univariate models. Two variables were fully analysed (i.e. the Country, and the Previous winter mortality). The main conclusions concerning the other variables were included in a synthetic analysis (see Table 16)

The Country variable

Data from Portugal were included for this analysis (see Appendix D – special check A). Please refer to Appendix G1 for the distribution of apiaries in all MS.

During EPILOBEE first year, the highest rate of winter mortality was recorded in Belgium (31.73%) and the lowest in Italy (5.01%). The highest seasonal mortality rate was recorded in France (9.63%) and the lowest in Lithuania (0.09%) (Figure 1).

During EPILOBEE second year, the highest rate of winter mortality was also recorded in Belgium (13.85%), and the highest rate of seasonal mortality was recorded in France (8.06%). The lowest rates of winter and seasonal mortality were recorded in Lithuania (2.16% and 0.16%, respectively) (Figure 2).

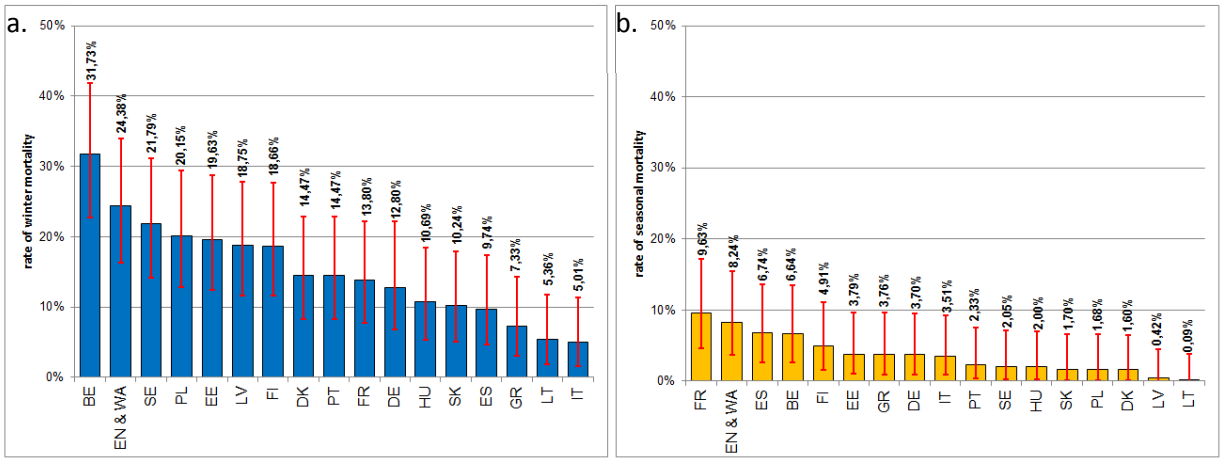

Figure 1: Winter (a) and seasonal (b) mortality rates according to the country during EPILOBEE *first* year. The red line segments represent the 95% confidence intervals.

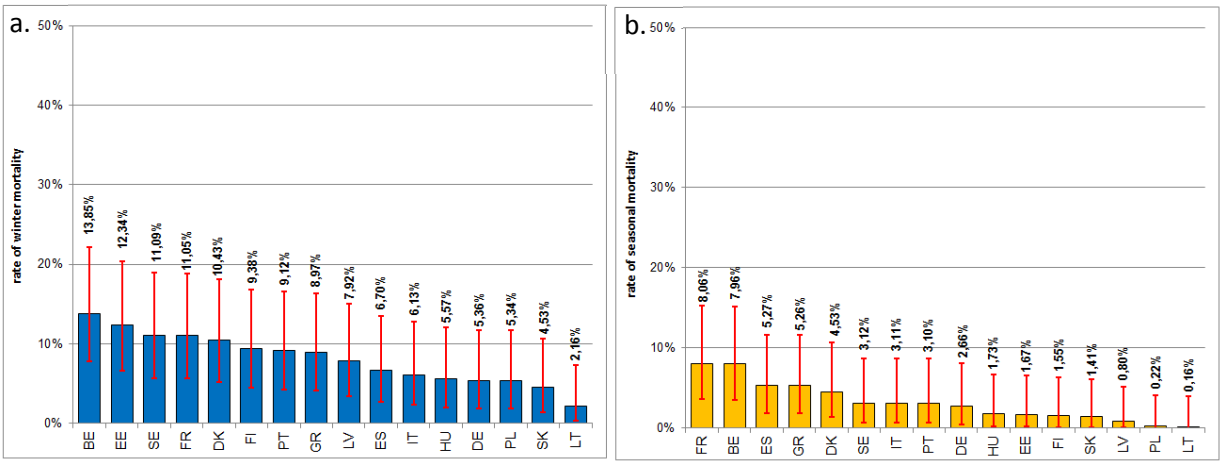

Figure 2: Winter (a) and seasonal (b) mortality rates according to the country during EPILOBEE *second* year. The red line segments represent the 95% confidence intervals.

The preliminary analysis had shown that the country had a statistically significant effect on the mortality (Appendices H1 and H2): this meant that at least one comparison between two MS was significantly different. To know which MS was different from the other a pairwise comparison was performed, please refer to the Appendix J.

During EPILOBEE first year :

- The winter mortality rate of Belgium was significantly different from all the other rates
- The rate for Italy was significantly different from all the others, with the exception of Greece and Lithania.
- The rate for Denmark was significantly different from the rates of Belgium, England and Wales, Sweden, Greece, Latvia and Italy.

The winter mortality rates of Denmark and Portugal were identical (14.47%, i.e. p-value = 1.00).

- The seasonal mortality rate for France was signicantly different from all the other rates, with the exception of England and Wales and Spain.
- The rate for Lithuania was significantly different from the rates for France, England and Wales, Spain, Belgium and Finland.
- The rate for Greece was significantly different from the rate for France, England and Wales, Spain, Belgium and Finland.

The seasonal mortality rates in Greece and Estonia were almost identical (3.76% and 3.79% respectively, i.e. p-value = 0.98).

During EPILOBEE second year :

- The winter mortality rate for Belgium was significantly different from all the other rates, with the exception of Estonia, Sweden, France and Denmark. The rate for Greece was not significantly different from the one for Belgium, due to a too small number of apiaries in Greece (Appendix G1).
- The winter mortality in Lithuania was significantly different from all the others.
- The rate for Latvia was significantly different from the rate for Belgium, Estonia, Slovakia and Lithuania.
- The seasonal mortality rate for France was significantly different from all the other rates, with the exception of Belgium. Similarly to the previous case, the rate for Greece was not significantly different from the one for France, due to a too small number of apiaries in Greece (Appendix G1).
- The winter mortality in Lithuania was significantly different from all the others, with the exception of Finland, Slovakia, Latvia and Poland.
- The rate for Sweden was significantly different from the rates for Belgium, France, Latvia, Poland and Lithuania.

As an additional analysis, all these rates were compared to the threshold of 10% for the winter mortality and to the European mean mortality for the seasonal mortality.

During EPILOBEE first year:

The winter mortality rates for Belgium, England and Wales, Sweden, Poland, Estonia, Latvia, Finland, Denmark, Portugal, France, Lithuania and Italy were significantly different from the 10% threshold (Figure 3).

The seasonal mortality rates for France, England and Wales, Spain, Belgium, Hungary, Slovakia, Poland, Latvia and Lithuania were significantly different from the European mean mortality (4.04%). The rate for Denmark was not significantly different from the European mean mortality, due to a too small number of apiaries in Denmark (Figure 3).

During EPILOBEE second year:

The winter mortality rates for Belgium, Spain, Italy, Hungary, Germany, Poland, Slovakia and Lithuania were significantly different from the 10% threshold (Figure 4).

The seasonal mortality rates for France, Belgium, Spain, Estonia, Finland, Slovakia, Latvia, Poland and Lithuania were significantly different form the European mortality mean (3.19%) (Figure 4).

a. b.

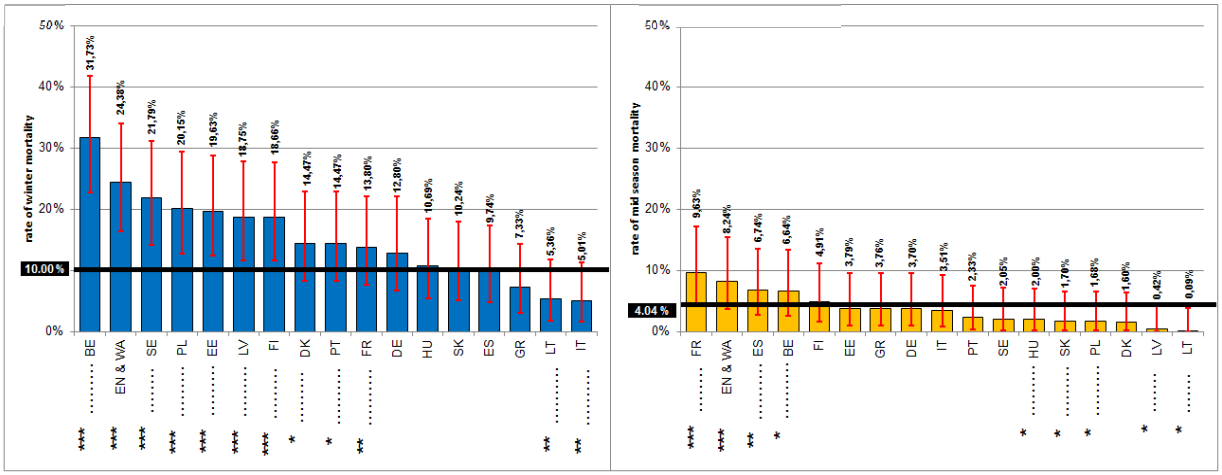

Figure 3: Effect of the variable *Country*. Comparisons with a threshold of 10 % for the winter mortality (a) and with the European mean mortality (4.04 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001). The red line segments represent the 95% confidence intervals.

a. b.

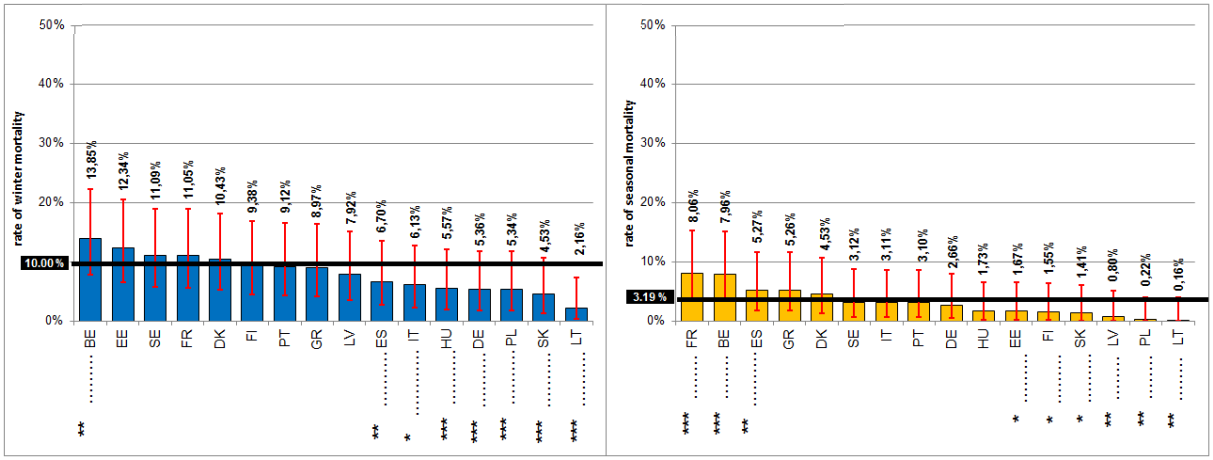

Figure 4: Effect of the variable *Country* . Comparisons with a threshold of 10% for the winter mortality (a) and with the European mean mortality (3.19%) for the seasonal mortality (b) during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

Clustering the MS

A specific analysis was conducted in order to cluster the MSs into four groups. The clusters were built taking into account the rate of mortality for each MS. These rates were analysed by the HCPC function from the FactoMineR R package. Belgium appeared different from all the other MSs for the winter mortality during EPILOBEE first year, and Lithuania different from all the other MSs for the winter mortality during EPILOBEE second year (Figures 5 and 6).

During EPILOBEE first year :

For the winter mortality, the group with the lowest mortality included Greece, Lithuania and Italy. The highest mortality was recorded in Belgium.

For the seasonal mortality, Sweden, Hungary, Portugal, Slovakia, Poland, Denmark, Latvia and Lithuania were part of the lowest mortality group. France and England and Wales were in the highest mortality group (Figure 5).

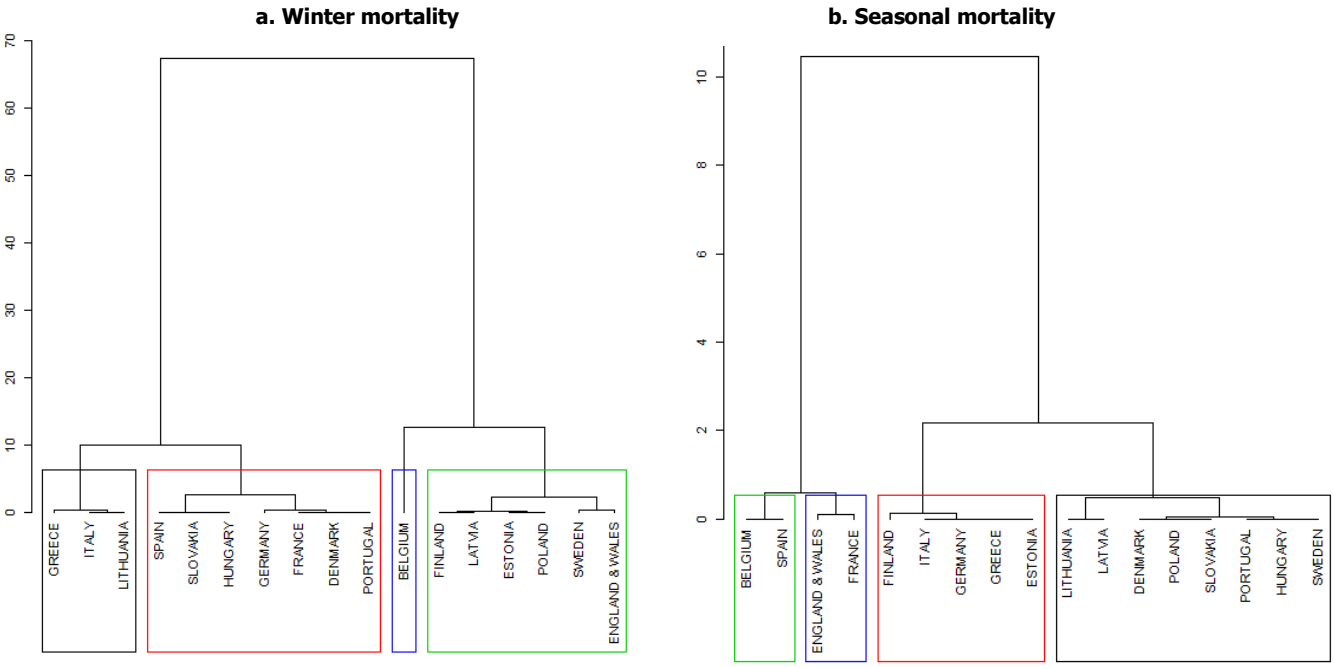

Figure 5: MS clustering for winter (a) or seasonal (b) mortality during EPILOBEE *first* year. MSs in different boxes had different mortality rates. Boxes in blue: high mortaliy rates, in green: medium high mortality rates, in red: medium low mortality rates and in black: low mortality rates. The vertical axe representes the distance in the differences.

During EPILOBEE second year :

For the winter mortality, Lithuania with the lowest mortality was separated from all the other MSs. The highest mortality was recorded in Belgium, Estonia, Sweden, France and Denmark.

For the seasonal mortality, Hungary, Estonia, Finland, Slovakia, Latvia, Poland and Lithuania were part of the lowest mortality group. France and Belgium were in the hightest mortality group (Figure 6).

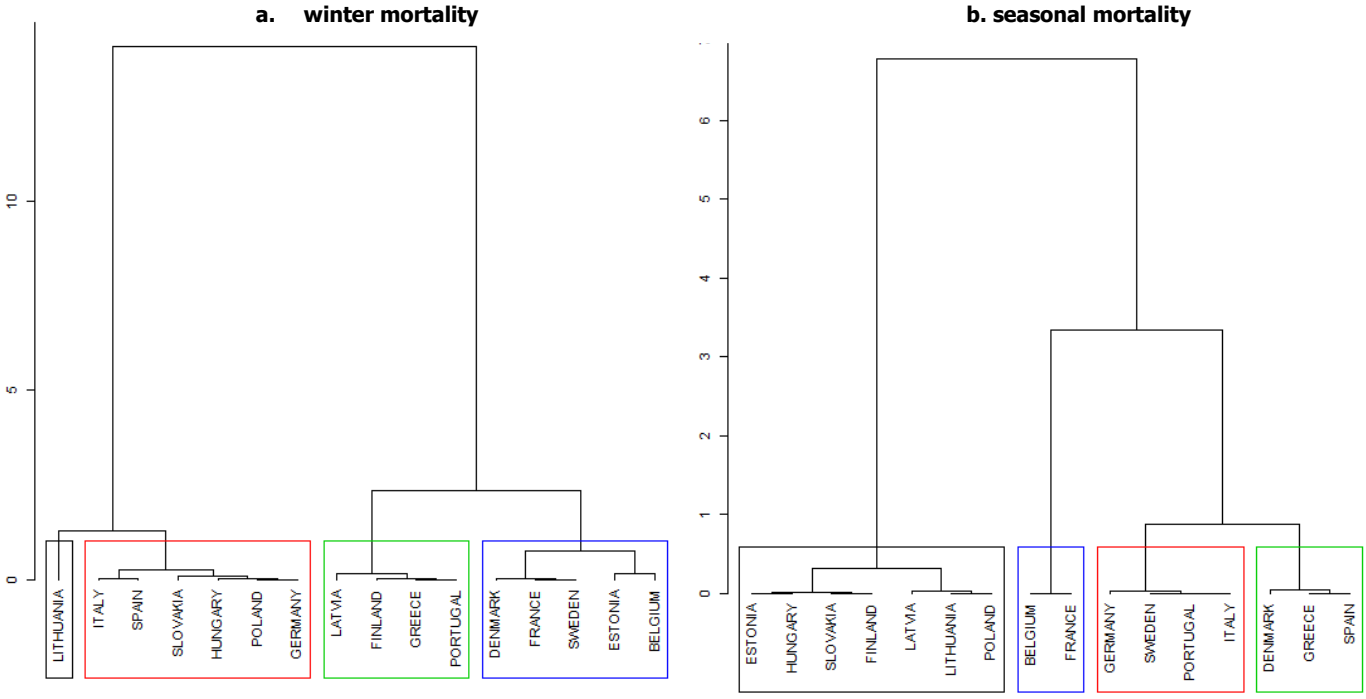

Figure 6: MS clustering for winter (a) or seasonal (b) mortality during EPILOBEE *second* year. MSs in different boxes had different mortality rates. Boxes in blue: high mortaliy rates, in green: medium high mortality rates, in red: medium low mortality rates and in black: low mortality rates. The vertical axe representes the distance in the differences.

The previous winter mortality

The variable *Winter_mortality_class* was only studied with seasonal mortality as response variable. In order to be analysed in the same way as the other variables, the continuous variable "winter mortality" was transformed into categories with five categories: no mortality; 1 – 5 %; 6 – 10 %; 11 – 20 %; 21 – 50 % and more than 50 %. Please also refer to Appendix G16 for the distribution of apiaries according to the previous winter mortality.

A high mortality rate (between 21 and 50 % and more than 50 %) during the previous winter was statistically linked with the two highest seasonal mortality rates (6.93 % and 5.63 % respectively for EPILOBEE first year and 6.20 % and 6.21 respectively % for EPILOBEE second year) (Figures 7 and 8). A low mortality rate (between 1 and 5 %) during the previous winter was linked with the lowest seasonal mortality rates for the first and second years of EPILOBEE (1.05 % for EPILOBEE first year and 2.00 % for EPILOBEE second year) (Figures 7 and 8).

During EPILOBEE first year, the seasonal mortality rate of apiaries with a mortality between 21 and 50 % during the previous winter was significantly different from the rates for the apiaries with a mortality between 11 and 20 % during the previous winter, those with a mortality between 6 and 10 % and those without any mortality during the previous winter (Appendix J16). The seasonal mortality rate of apiaries with a mortality between 21 and 50 % during the previous winter, was not significantly different from the rate for the apiaries with a mortality between 1 to 5 %, due to a too small number of apiaries composing this group (Appendix G16).

During EPILOBEE second year, the seasonal mortality rate of apiaries without any mortality during the previous winter was significantly different from all the other rates, with the exception of the rate

for the apiaries with a mortality between 1 and 5 % during the previous winter (this group was composed of a too small number of apiaries) (Appendix J16).

For EPILOBEE first year, the mortality rates of apiaries with a mortality between 21 to 50 % during the previous winter and of those without any mortality during the past winter were both significantly different from the European mean mortality (4.12 %). Due to a too small number of apiaries, the rate of apiaries with a mortality between 6 and 10 % was not significantly different from the European mortality mean (Figure 7).

For EPILOBEE second year, the mortality rates of apiaries with a mortality between 21 to 50 % during the previous winter, those with a mortality between 11 and 20 %, and those without any mortality during the past winter were significantly different from the European mean mortality (3.19 %). Due to a too small number of apiaries, the rate of apiaries with a mortality superior to 50 % was not significantly different from the European mean mortality (Figure 8).

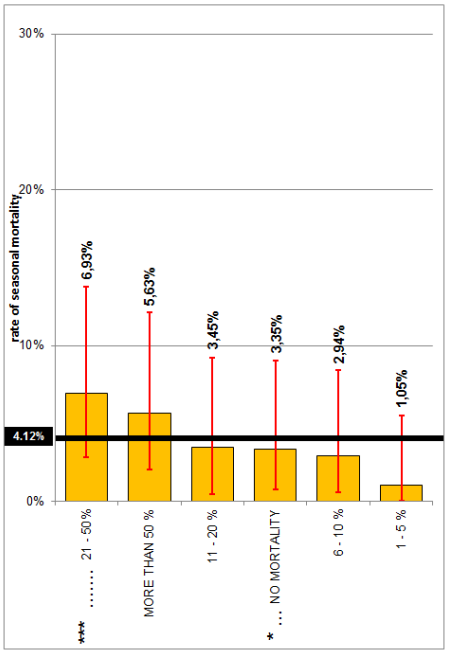

Figure 7: Effect of the Previous winter mortality variable. Comparison with the European mean mortality (4.12 %) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

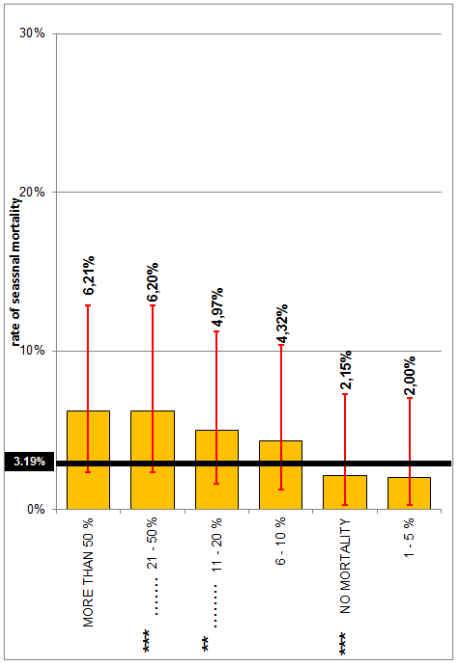

Figure 8: Effect of the Previous winter mortality variable. Comparison with the European mean mortality (3.19 %) during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01;***<0.001) . The red line segments represent the 95% confidence intervals.

The links between the two mortalities were explored as continuous variables and found to be positive, although not very strong for both years of EPILOBEE (Figures 9 and 10). Spearman correlation coefficients for EPILOBEE first year and EPILOBEE second year were statistically different from zero (p-value=$6x10^{-4}$ and 2 x 10^{-12} respectively) and the positive link between the two mortalities was slightly stronger during EPILOBEE second year (Spearman correlation coefficient = 0.142) than during EPILOBEE first year (Spearman correlation coefficient = 0.071).

Figure 9: Link between the winter and the seasonal mortalities, during EPILOBEE *first* year.

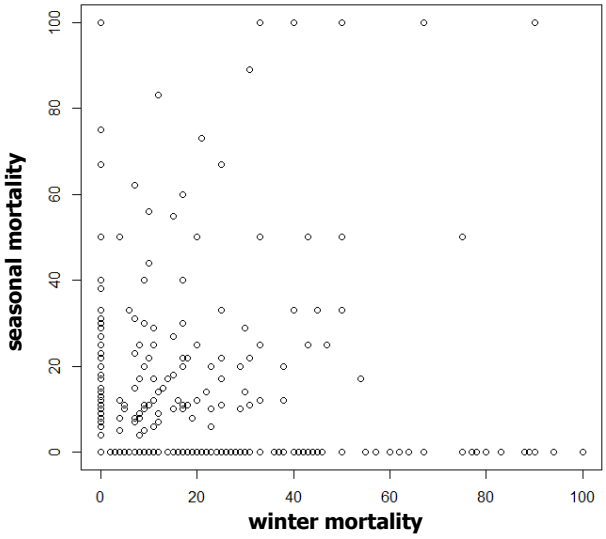

Figure 10: Link between the winter and the seasonal mortalities, during EPILOBEE *second* year

Synthetic analysis

The Table 16 provided an overview of the winter and the seasonal mortalities for the first and second years of EPILOBEE.

For a given variable (composed of at least three categories), please refer to:

- Appendix G for the distribution of apiaries according to the different categories,
- Appendix I for the comparisons with the 10 % threshold or with the European mean mortality,
- Appendix J for the pairwise comparisons between the different categories.

Table 16: Distribution of the apiaries, winter and seasonal mortality rates during the *first* and *second* years of EPILOBEE for each category of the 36 variables kept in the analysis. When the variable had a statistically significant effect on the mortality (either winter or seasonal), rates were highlighted in yellow.

Variables	Categories	EPILOBEE *first* year (%)	winter mortality rate (%)	seasonal mortality rate (%)	EPILOBEE *second* year (%)	winter mortality rate (%)	seasonal mortality rate (%)
Age							
	Less than 30	4,35	12,95	3,1	3,91	6,51	3,96
	30-45	23,11	15,59	3,81	21,63	8,72	3,59
	45-65	47,37	13,95	3,89	49,12	7,55	2,79
	Over 65	25,17	17,46	5,26	25,34	8,48	3,33
Activity							
	Hobby	64,72	17,42	4,36	62,65	8,51	3,17
	Part-time	16,9	13,02	4,26	18,8	7,01	3,04
	Professional	18,38	8,83	3,16	18,54	6,8	2,76
Beekeep_for							
	Less than 2 years	6,97	19,28	4,36	4,93	7,3	3,21
	2 - 5 years	15,33	16,46	3,16	14,79	9,3	3,35
	More than 5 years	77,7	14,66	4,26	80,28	7,94	3,13
Qualif							
	Yes	43,31	15,19	4,31	47,71	7,52	3,17
	No	56,69	15,12	4,47	52,29	8,72	3,47
Training							
	Yes	62,45	13,2	3,82	62,92	7,22	2,98
	No	37,55	15,02	4,94	37,08	9,67	3,9
Coop_treat							
	Yes	55,73	14,98	3,39	57,93	8,28	3
	No	44,27	15,85	5,31	42,07	8,95	3,77
Bee_population_size							
	Less than 51 colonies	70,5	17,38	4,21	70,36	8,76	3,29
	51-100 colonies	10,72	10,77	2,47	11,75	6,2	1,61
	101-150 colonies	4,55	10,2	3,71	4,04	5,57	2,3
	150-200 colonies	3,09	8,85	4,68	3,87	7,12	4,36
	201-300 colonies	3,39	5,81	2,7	3,05	7,22	4,19
	More than 300 colonies	7,76	8,5	6,27	6,92	6,14	4,29
Apiary_Size							
	Less than 5 colonies	28,47	19,13	4,96	21,31	10,06	5,23
	6-10 colonies	19,73	18,5	4,1	12,94	10,44	4,44
	11-20 colonies	16,94	14,57	4,39	11,21	8,39	3,15
	21-50 colonies	16,98	12,21	3,16	12,28	5,47	2,45
	More than 50 colonies	17,88	7,63	3,47	42,25	6,93	2,01
Production							
	Only honey	77,01	15,99	4,04	74,12	8,78	3,32
	Includes pollen production	6,65	13,44	3,32	7,6	4,79	1,54
	Includes pollination services	1,22	18,07	1,22	1,83	7,55	5,87
	Includes queens production	1,95	13,02	6,72	2,74	6,26	0,98
	Includes royal jelly production	0,9	8,1	2,8	0	0	0
	Inlcudes swarms production	5,97	11,92	4,75	7,31	5,68	2,47
	Other	6,29	9,9	4,02	6,4	7,04	2,71
Apiarist book							
	Yes	72,23	13,07	3,85	76,1	8,05	3,17
	No	27,77	17,07	4,41	23,9	9,75	4,47
Org_member							

Variables	Categories	EPILOBEE *first* year (%)	winter mortality rate (%)	seasonal mortality rate (%)	EPILOBEE *second* year (%)	winter mortality rate (%)	seasonal mortality rate (%)
	Yes	87,14	14,87	4,23	88,47	7,92	3,22
	No	12,86	17,59	4,31	11,53	9,63	2,5
Continue							
	Yes	98,15	15,31	4,34	98,84	7,94	3,13
	No	1,85	13,47	2,82	1,16	10,95	5,18
Breed							
	A. m. carnica	33,33	15,13	3,07	37,08	6,72	1,93
	A. m. ccm	2,41	11,9	5,96	1,55	7,54	8,66
	A. m. iberiensis	3,17	7,21	7,7	3,2	6,49	4,06
	A. m. ligustica	10,83	14,55	3,41	11,63	8,58	2,54
	A. m. mellifera	9,93	13,08	4,73	6,44	7,94	4,75
	Buckfast	10,97	18,56	2,69	15,32	10,28	3,81
	Hybrid	18,68	18,18	6,32	9,68	10,45	5,04
	Local bees	10,69	9,98	4,75	15,1	8,67	3,77
Chronic_Depop							
	Yes	8,82	18,83	7,54	4,96	10,78	5,58
	No	91,18	15,3	4,08	95,04	8,01	3,14
ClinSign_Brood							
	Yes	13,39	16,11	8,13	7,27	11,01	7,74
	No	86,61	15,49	3,86	92,73	7,92	2,91
ClinSign_Honeybees							
	Yes	11,98	18,56	6,98	6,5	11,8	5,28
	No	88,02	15,17	4,03	93,5	7,89	3,12
H_rate_ColMortality							
	Yes	25,5	23,77	6,94	17,53	12,59	6,23
	No	74,5	12,98	3,57	82,47	7,24	3,52
H_rate_HoneyMortality							
	Yes	20,03	15,22	8,27	6,41	10,58	6,21
	No	79,97	15,63	3,95	93,59	7,98	3,06
Other_Event							
	Yes	9,62	17,38	6,21	5,09	8,93	5,06
	No	90,38	15,43	4,2	94,91	8,11	3,17
VarroaMites							
	Yes	28,46	16,22	4,15	17,06	9,86	3,02
	No	71,54	15,27	4,47	82,94	7,79	3,31
QueenProblems							
	Yes	15,61	18,84	7,51	8,25	11,52	7,21
	No	84,39	14,98	3,81	91,75	7,84	2,91
Management							
	Livestock	48,96	12,11	3,88	49,62	8,12	3,03
	Production	0,92	17,95	1,21	0,9	0,62	1,62
	Health conditions	0	0	0	3,24	8,72	3,93
	Livestock+Production	6,08	7,78	1,26	3,03	4,79	3,58
	Livestock+Health conditions	1,06	11,91	4,36	10,62	8,88	5,46
	Production+Health conditions	0	0	0	0,9	4,67	0,38
	Production+Livestock+Health conditions	2,32	14,19	1,69	6,78	6,46	1,53
	No Information	40,66	19,96	5,56	24,91	7,89	2,9
Swarm_bought							
	None	57,16	11,21	3,3	70,45	7,56	3,12
	1 swarm bought	1,72	16,15	2,65	1,57	12,79	1,74
	2-5 swarms bought	2,4	23,52	3,09	2,27	15,58	7,29
	More than 5 swarm bought	2,62	20,79	4,21	1,65	15,7	6,2

Variables	Categories	EPILOBEE *first* year (%)	winter mortality rate (%)	seasonal mortality rate (%)	EPILOBEE *second* year (%)	winter mortality rate (%)	seasonal mortality rate (%)
	No information	36,11	19,96	5,56	24,07	7,89	2,9
Swarm_produced							
	None	20,41	13,5	3,89	38,58	7,69	3,23
	1 swarm produced	15,52	13,38	2,72	17,64	9,61	3,15
	2-5 swarms produced	8,83	10,52	2,31	6,27	8,05	3,38
	More than 5 swarm produced	19,13	10,64	3,63	13,44	7,21	3,59
	No information	36,11	19,96	5,56	24,07	7,89	2,9
Queen_bought							
	None	44,51	11,54	3,82	58,08	8,05	3,48
	1-5 queen(s) bought	7,85	15,73	2,01	9,15	9,39	3,59
	6-10 queens bought	3,51	16,57	2,83	3,22	8,87	0,94
	More than 10 queens bought	8,02	10,5	1,99	5,48	5,74	2,14
	No information	36,11	19,96	5,56	24,07	7,89	2,9
Queen_produced							
	None	29,55	13,59	4,08	46,95	8,64	3,97
	1-5 queen(s) produced	9,81	14,78	2,26	12,2	8,56	2,05
	6-10 queens produced	6,48	11,95	2,07	4,33	7	2,06
	More than 10 queens produced	18,05	8,61	3,07	12,41	5,8	2,36
	No information	36,11	19,96	5,56	24,11	7,92	2,9
MidSeason_Target							
	Wild flowers	3,92	9,62	-	3,18	5,06	-
	Crops	3,87	11,09	-	3,43	7,94	-
	Diverse	6,02	11,89	-	6,12	6,3	-
	Other	5,16	13,02	-	2,36	10,07	-
	No Information	81,02	15,83	-	84,9	8,23	-
Environment							
	Diverse	85,51	15,25	3,97	91,88	7,67	2,87
	Farmland	4,49	15,69	3,92	2,04	8,57	5,83
	Floral	4,44	9,91	5,69	2,5	6,45	7,49
	None	0,61	16,69	4,62	0,72	6,64	1,29
	Orchards	1,36	6,48	4,14	0,82	2,94	1,44
	Town & Industries	1,64	20,4	7,03	1,07	5,71	3,05
	Wood	1,96	15,79	3,43	0,97	16,47	1,74
AmericanFoulbroodV1							
	Yes	2,36	30,6	-	1,57	26,79	-
	No	97,64	14,63	-	98,43	7,74	-
AmericanFoulbroodV2							
	Yes	1,84	-	12,86	1,65	-	8,07
	No	98,16	-	3,96	98,35	-	3,11
EuropeanFoulbroodV1							
	Yes	1,03	17,83	-	0,37	11,22	-
	No	98,97	14,63	-	99,63	8,02	-
EuropeanFoulbroodV2							
	Yes	1,03	-	20,04	0,62	-	13,8
	No	98,97	-	3,96	99,38	-	3,13
VarroosisV1							
	Yes	14,88	20,95	-	4,12	9,82	-
	No	85,12	13,96	-	95,88	7,96	-
VarroosisV2							
	Yes	12,82	-	5,22	4,08	-	6,05
	No	87,18	-	3,96	95,92	-	3,07
NosemosisV1							
	Yes	0,6	22,71	-	0,78	7,21	-

Variables	Categories	EPILOBEE *first* year (%)	winter mortality rate (%)	seasonal mortality rate (%)	EPILOBEE *second* year (%)	winter mortality rate (%)	seasonal mortality rate (%)
	No	99,4	14,96	-	99,22	8,94	-
NosemosisV2							
	Yes	7,98	-	4,77	4,04	-	3,39
	No	92,02	-	4,07	95,96	-	3,19
ChronicParalysisV1							
	Yes	0,69	16,62	-	0,58	7,07	-
	No	99,31	14,99	-	99,42	8,04	-
ChronicParalysisV2							
	Yes	0,9	-	6,19	1,53	-	3,51
	No	99,1	-	4,11	98,47	-	3,19
Migration							
	Yes	19,85	11,3	3,68	15,83	6,86	4,49
	No	80,15	15,92	4,23	84,17	8,26	2,95
Merger							
	Yes	9,01	18,47	6,88	8,95	12,86	6,53
	No	90,99	14,66	3,84	91,05	7,46	2,9
Winter_mortality_class							
	No mortality	52,53	-	3,35	65,25	-	2,15
	1-5 %	1,76	-	1,05	1,98	-	2
	6-10 %	7,46	-	2,94	6,92	-	4,32
	11-20 %	12,78	-	3,45	12,32	-	4,97
	21-50 %	18,27	-	6,93	11,75	-	6,2
	More than 50 %	7,5	-	5,63	1,77	-	6,21
First_Second							
	Yes	-	-	-	19,66	8,13	3,42
	No	-	-	-	80,34	8,01	3,14

During EPILOBEE first year, 22 variables out of 36 had a statistically significant effect on the **winter mortality**. Amongst them, 14 also had a statistically significant effect on the winter mortality during EPILOBEE second year. The same tendency was observed for the **seasonal mortality** with 18 variables having a statistically significant effect during the first year: amongst them, 15 also had a statistically significant effect on the seasonal mortality during the second year. Ten variables had a statistically significant effect on winter and seasonal mortalities during the first and second years of EPILOBEE.

Beekeeper age

The age of the beekeeper had a statistically significant effect on the winter mortality during EPILOBEE first year. The mortality rates in apiaries managed by beekeepers over 65 years of age (17.46 %) and beekeepers between 45 and 65 years (13.95 %) were significantly different. The age of the beekeeper had no effect on the seasonal mortality during the first and second years of EPILOBEE. When the winter mortality (for EPILOBEE first year) was compared to the threshold of 10 %, the older the beekeepers were, the more significant the difference was. This was not the case for the seasonal mortality when compared to the European mortality mean.

Beekeeper activity

The beekeepers activity had a statistically significant effect on the winter mortality for the first and second years of EPILOBEE but not on the seasonal mortality for both years. The winter mortality was significantly different for each category (17.42 %, 13.02 % and 8.83 % for hobbyist, part-time and professional respectively) for EPILOBEE first year, and only for hobbyist (8.51 %) and part time beekeepers (6.80 %) for the second year. The winter mortality rates during the first year of apiaries managed by hobbyist (17.42 %) and part time beekeepers (13.02 %) were significantly different from

the threshold of 10 %. During the second year, the winter mortality rates of apiaries managed by hobbyist, professional and part-time beekeepers (8.51 %, 7.01 % and 6.80 % respectively) were significantly different to the threshold.

The apiary size and the size of the operation

The apiaries size and the size of the operation (= *Bee_population_size*, i.e the total number of colonies owned by a beekeeper) explained part of the mortality. Indeed, in both cases the effect was statistically significant (with a tendency to oppose the smallest apiaries to the biggest apiaries) except for the seasonal mortality of EPILOBEE first year (Table 16). During the first year, all the winter mortality rates were significantly different from the threshold of 10 % (19.13 %, 18.50 %, 14.57 %, 12.21 % and 7.63 % for less than 5 colonies, 6-10 colonies, 11-20 colonies, 21-50 colonies and more than 50 colonies respectively). Winter mortality rates of biggest apiaries were significantly different from this threshold during the second year (5.47 % and 6.93 % for 21-50 colonies and more than 50 colonies respectively). Winter mortality rates of both years in the smallest (less than 51 colonies) and the biggest operations (201-300 colonies or more than 300 colonies) were significantly different from the threshold of 10 %.

The production of the beekeeper

The production of the beekeeper had a statistically significant effect on the winter mortality for the first and second years of EPILOBEE. The winter mortality rate of apiaries managed by beekeepers producing only honey (15.99 %) was significantly different from the rate of those managed by beekeepers with another production (9.90 %) during the first year. During EPILOBEE second year, the winter mortality rate of apiaries managed by beekeepers producing only honey (8.78 %) was significantly different from the rates of those managed by beekeepers with a production including swarm (5.68 %) and of the ones managed by beekeepers with a production including pollen (4.79 %). For both years, the winter mortality rates of apiaries managed by beekeepers producing only honey (15.99 % and 8.78 % for the first and second years of EPILOBEE respectively) and of those managed by beekeepers with a production including pollen (13.44 % and 4.79 % for the first and second years of EPILOBEE respectively) were significantly different from the threshold of 10 %.

The honeybee breed

The honeybee breeds had a statistically significant effect on all the mortalities (winter and seasonal mortalities for the first and second years of EPILOBEE). The mortality rates of apiaries with *A. m. carnica* honeybees were significantly different from the rates of apiaries with hybrid. During EPILOBEE first year only, the winter mortality rate of apiaries with *A. m. carnica* honeybees (15.13 %) was significantly different from the rate of apiaries with *A. m. iberiensis* honeybees (7.21 %). Only the winter mortality rates of apiaries with *A. m. carnica* honeybees was significantly different from the threshold of 10 % during the first and second years of EPILOBEE (15.13 % and 6.72 % respectively).

High rate of colony mortality experienced before the autumn visit

A higher rate of winter mortality was notable in apiaries which experienced a high rate of colony mortality before the autumn visit (23.77 % and 12.59 % for the first and second years of EPILOBEE respectively) compared to the rate of those which did not experience any (12.98 % and 7.24 % for the first and second years of EPILOBEE respectively). The two winter mortality rates from the first year were significantly different. It was also the case with the two rates from the second year.

Clinical signs in honeybees experienced before the autumn visit

Mortality rates of apiaries managed by beekeepers who experienced clinical signs on honeybees were significantly different from the rates of apiaries managed by beekeepers which did not experience any.

Queens and swarms bought – Queens and swarms produced

Buying swarms had a statistically significant effect on the winter and seasonal mortalities during the first and second years of EPILOBEE, contrary to producing swarms which only had a statistically significant effect during first year. In these two cases, the lowest winter mortality rate was recorded for apiaries managed by beekeepers who did not buy any swarms during the first and second years of EPILOBEE (11.21 % and 7.56 % respectively). For the seasonal mortality, the lowest rate was recorded for apiaries managed by beekeepers who bought only one swarm, during the first and second years of EPILOBEE (2.65 % and 1.74 % respectively). Buying queens only had a statistically significant effect on the winter and the seasonal mortalities during EPILOBEE first year contrary to producing queen which had a statistically significant effect during the first and second years. During the first year, the lowest mortality rates were recorded by the apiaries managed by beekeepers who bought more than 10 queens (10.50 % and 1.99 % for the seasonal and the winter mortality respectively).

The environment surrounding the apiary

The environment surrounding the apiary had a statistically significant effect on the winter mortality during EPILOBEE first year. Indeed, the winter mortality rates in the first year of apiaries near towns and industries (20.40 %) were significantly different from the rates of apiaries near a floral environment (9.91 %) and of those near orchards (6.48 %). During the first and second years of EPILOBEE, the winter mortality rates of the apiaries near a diverse environment (15.25 % and 7.67 % for the first and second years of EPILOBEE respectively) were significantly different from the threshold of 10%.

Prevalence of disease

Concerning diseases, the mortality rates of apiaries which suffered from AFB were significantly different from the rates of those which did not suffer from AFB. The mortality rates of apiaries which suffered from EFB, Varroosis or Chronic paralysis were most of the time significantly different from the rates of apiaries who which did not suffer from these diseases (please refer to Table 16 for more details). The mortality rates of apiaries which suffered from Nosemosis were never significantly different from the rates of those which did not suffer from Nosemosis.

Migration of the apiary

Concerning the migration, a statistically significant effect was found for the winter mortality during EPILOBEE first year and for the seasonal mortality during the second year. During the first year, the winter mortality rate of apiaries with migration and those without any migration were significantly different (11.30 % and 15.92 % respectively). During the second year, the seasonal mortality rate of apiaries with migration and those without any migration were also significantly different (4.49 % and 2.95 % respectively).

Some variables had punctual effects on the winter or seasonal mortalities during the first or second years of EPILOBEE : using an apiarist book, taking part in a cooperative treatment against varroa, apiaries with varroa mites and the training of beekeepers. In the same way, other variables which were significant were difficult to interpret: management and the environment targeted during the previous seasonal migration (See 5. Recommandations). The rates of the seasonal mortality were not statistically different from the European mean mortality (Appendix I) with the exception of beekeepers with a livestock of more than 300 colonies during the first year (higher mortality), beekeepers with a livestock of 51-100 colonies for the second year (lower mortality), honeybee breed and buying or producing queens and swarms. Please refer to the Table 16 and the Appendices G, I, J for all the details.

3.2. Overall study (both years of EPILOBEE combined)

3.2.1. Overall study: preliminary results

Step 1: Imputation of missing data

Missing data were handled by means of an imputation method to keep as much data as possible in the data set for statistical analysis (2.4.2. The statistical methody – Overall study– Step 1). For a given variable in a given apiary, the imputation method analysed the content of the others variables in the database and replaced the missing data by the most probable category (Tables 17 and 18).

Table 17: Imputation of missing data for EPILOBEE *first* year.

Variables	Number of NA	NA replaced by the category	Number of imputations
Age	238	45-65	238
Activity	36	Hobby	36
Beekeep_for	251	More than 5 years	251
Qualif	330	No	298
		Yes	32
Training	468	No	25
		Yes	443
Coop_treat	315	No	72
		Yes	243
Production	122	Honney	122
Apiarist_book	427	No	2
		Yes	425
Org_member	232	Yes	232
Continue	280	Yes	280
Breed	217	*A. m. carnica*	163
		A. m. mellifera	9
		Buckfast	11
		Hybrid	30
		Local bees	4
Chronic_Depop	212	No	212
ClinSign_Brood	211	No	211
ClinSign_Honeybees	211	No	211
H_Rate_ColMortality	203	No	203
H_Rate_HoneyMortality	209	No	209
OtherEvent	212	No	212
VarroaMites	206	No	199
		Yes	7
QueenProblems	212	No	212
Management	261	Livestock	261
MidSeason_Target	8	No Information	8
Environment	192	Diverse	192
Merger	2	No	2

NA were missing data

Table 18: Imputation of missing data for EPILOBEE *second* year.

Variables	Number of NA	NA replaced by the category	Number of imputations
Age	433	45-65	401
		Over 65	32
Activity	134	Hobby	134

Variables	Number of NA	NA replaced by the category	Number of imputations
Beekeep_for	458	More than 5 years	458
Qualif	600	No	316
		Yes	264
Training	603	No	90
		Yes	513
Coop_treat	655	No	24
		Yes	631
Production	347	Honney	347
Apiarist_book	719	Yes	719
Org_member	440	Yes	232
Continue	526	Yes	526
Breed	174	*A. m. carnica*	118
		A. m. iberiensis	1
		A. m. ligustica	14
		A. m. mellifera	22
		Buckfast	11
		Local bees	8
Chronic_Depop	88	No	88
ClinSign_Brood	88	No	88
ClinSign_Honeybees	87	No	87
H_Rate_ColMortality	82	No	81
		Yes	1
H_Rate_HoneyMortality	87	No	87
OtherEvent	88	No	212
VarroaMites	87	No	87
QueenProblems	87	No	212
Management	82	Livestock	82
		Production + Livestock + HealthConditions	1
MidSeason_Target	8	No Information	8
Environment	468	Diverse	468
Merger	214	No	214

NA were missing data

Step 2: Selection of the explanatory variables related to mortalities

Please remember that this imputation method was performed separately for EPILOBEE first and second years. Subsequently, the two complete datasets were merged into one new dataset. A last variable (37th, i.e. *Program*) was added at the new dataset in order to differentiate data from the first year and those from the second year. The new dataset was composed of **4 758 apiaries** (2 332 + 2 426).

A new selection of variables was implemented according to the p-value calculated with the new dataset: please note that contrary to the study conducted for each year of EPILOBEE (0.05 threshold), a 0.20 threshold was used in order to select variables to be analysed in the next steps (Appendices K1 and K2).

Consequently to this analysis, for the overall study on winter mortality, most of the variables were selected with the exception of *Continue, EuropeanFoulbroodV1, NosmosisV1* and *ChronicParalysisV1*. Finally, **33 variables** were selected.

For the overall study on seasonal mortality, **28 variables** were selected (i.e. without *Beekeep_for, Qualif, Production, Org_member, Continue, VarroaMites, Environment, NosemosisV2, ChronicParalysisV2* and *Migration*).

The year effect introduced by the *Program* variable was stronger for the winter mortality (p-value = $1x10^{-37}$, Appendix K1) than for the seasonal mortality (p-value = $1x10^{-3}$, Appendix K2), and both were significant.

Step 3: Summary of explanatory variables within consistent thematic

Most of the variables selected for the study were dependant of each other. To group the original variables, summarised variables were defined by the group of experts:

- Disease
- Management
- Health events
- Beekeeper background
- Size

These summarised variables were composed of the significant original variables (Table 19).

Table 19: Summarised variables produced from the original variables for the analysis of EPILOBEE data (2012-2014)

Summarised variables	Original variables	
	Winter mortality	Seasonal mortality
Disease	AmericanFoulbroodV1	AmericanFoulbroodV2
	VarroosisV1	VarroosisV2
	-	EuropeanFoulbroodV2
Management	Management	Management
	Queen bought	Queen bought
	Queen produced	Queen produced
	Swarm bought	Swarm bought
	Swarm produced	Swarm produced
	MidSeaason_Target	-
	Migration	-
	Merger	Merger
	Breed	Breed
	Production	-
	Environment	-
Health_events	Chronic_Depop	Chronic_Depop
	ClinSign_Brood	ClinSign_Brood
	ClinSign_Honeybees	ClinSign_Honeybees
	H_rate_ColMortality	H_rate_ColMortality
	H_rate_HoneyMortality	H_rate_HoneyMortality
	Other_Event	Other_Event
	VarroaMites	-
	QueenProblems	QueenProblems
Beekeeper_background	Apiarist book	Apiarist book
	Beekeep_for	-
	Org_member	-
	Qualif	Qualif
	Training	-
Size	Apiary_Size	Apiary_Size
	Bee_population_size	Bee_population_size

However, even after merging the variables into summarised variables, the variables were still correlated. Therefore the second step was to cluster the observations into groups according to the most represented modalites using MCA (Multiple Correspondance Analysis) and HCPC (Hierarchical Clustering on Principle Components) functions. For the winter and seasonal mortalities, new categories corresponding to clusters were identified (Table 20).

Table 20: Observations clustered for each summarised variable

Summarised variables	Observations clustered	
	Winter mortality	Seasonal mortality
Disease	cluster A1 : *AmericanFoulbroodV1 :* No *VarroosisV1 :* No	cluster A1 : *VarrosisV2 :* No *AmericanFoulbroodV2 :* No *EuropeanFoulbroodV2 :* No
	cluster A2 : *AmericanFoulbroodV1 :* No *VarroosisV1 :* Yes	cluster A2 : *VarrosisV2 :* Yes *AmericanFoulbroodV2 :* No *EuropeanFoulbroodV2 :* No
	cluster A3 : *AmericanFoulbroodV1 :* Yes *VarrosisV1 :* No	cluster A3 : *VarrosisV2 :* No *AmericanFoulbroodV2 :* Yes *EuropeanFoulbroodV2 :* No
		cluster A4 : *VarrosisV2 :* No *AmericanFoulbroodV2 :* No *EuropeanFoulbroodV2 :* Yes
Management	cluster B1 : *Management :* no information *Swarms / Queens bought :* no information *Swarms / Queens produced :* no information *Migration :* no information *MidSeason Target :* no information *Breed :* Buckfast - A. m. ligustica – Hybrid *Environment :* Farmland – Town – Wood *Production :* Includes queens production *Merger :* NCOR[8]	cluster B1 : *Management :* no information *Swarms / Queens bought :* no information *Swarms / Queens produced :* no information *Breed :* Buckfast - A. m. ligustica – Hybrid *Merger :* NCOR
	cluster B2 : *Management :* Production + Livecestock + Health Conditions *Swarms / Queens bought :* none *Swarms / Queens produced :* none *Migration :* no information *MidSeason Target :* no information *Breed :* Local bees – A. m. carnica *Environment :* Diverse *Production :* Only Honey *Merger :* No	cluster B2 : *Management :* Livestock *Swarms / Queens bought :* none *Swarms / Queens produced :* none *Breed :* Local bees – A. m. iberiensis *Merger :* No

[8] NCOR: No Category Over Represented. For a given summarised variable and a given cluster, it is possible that among all the categories, none is over represented.

Summarised variables	Observations clustered	
	Winter mortality	Seasonal mortality
	cluster B3 : *Management :* Livestock *Swarms / Queens bought :* none *Swarms / Queens produced :* more than 10 *Migration :* Yes *MidSeason_Target :* Crops - Diverse *Breed :* A.m. iberiensis – A. m. ccm *Environment :* Floral *Production :* Other *Merger :* Yes	cluster B3 : *Management :* Production + Livecestock + Health Conditions *Swarms / Queens bought :* more than 5 / more than 10 *Swarms / Queens produced :* more than 10 *Breed :* A.m. carnica - A. m. ccm *Merger :* Yes
Health_events	cluster C1 : All the event experienced	cluster C1 : All the event experienced
	cluster C2 : None event experienced	cluster C2 : All the event not experienced
Beekeeper_background	cluster D1 : *Apiarist_book :* Yes *Beekeeper_for :* Yes *Org_member :* Yes *Qualif :* Yes *Training :* More than 5 years	cluster D1 : *Apiarist_book :* Yes *Training :* Yes
	cluster D2 : *Apiarist_book :* No *Beekeeper_for :* No *Org_member :* No *Qualif :* No *Training :* Less than 2 years	cluster D2 : *Apiarist_book :* Yes *Training :* No
	cluster D3: *Apiarist_book :* No *Beekeeper_for :* No *Org_member :* No *Qualif :* No *Training :* 2 - 5 years	cluster D3 : *Apiarist_book :* No *Training :* Yes
		cluster D4 : *Apiarist_book :* No *Training :* No
Size	cluster E1: *Apiary_size :* less than 20 colonies *Bee_population_size :* less than 51 colonies	cluster E1: *Apiary_size :* less than 20 colonies *Bee_population_size :* less than 51 colonies
	cluster E2: *Apiary_size :* 21 – 50 colonies *Bee_population_size :* 151 – 200 colonies	cluster E2: *Apiary_size :* 21 – 50 colonies *Bee_population_size :* 151 – 200 colonies
	cluster E3: *Apiary_size :* more than 50 colonies *Bee_population_size :* 51 – 150 colonies and more than 200 colonies	cluster E3: *Apiary_size :* more than 50 colonies *Bee_population_size :* 51 – 150 colonies and more than 200 colonies

3.2.2. Statistical analysis for both years of EPILOBEE

Step 4: Elaboration of a new synthetic variable

After this clustering, data were still correlated. A third step was to build a new synthetic variable, from all the explanatory variables[9] (previous clusters were then used as new variables) included in a MCA in

[9] With the exception of the *Country* and *Program* variables which were included in the multivariate model as random effects.

order to analyse a workable variable without any correlation. Subsequently the HCPC function clustered this new synthetic variable into 7 clusters for the winter mortality and 7 others for the seasonal mortality.

For the winter mortality:

Cluster F1 (1 324 apiaries)

The first cluster was composed of hobbyist beekeepers over 65 years of age. These beekeepers had a small apiary and operation (cluster E1). The cluster gathered apiaries of Buckfast, hybrid and *A. m. ligustica* honeybees, located around a farmland environment or around an environment with town and woods. The apiaries were managed by beekeepers with a production including queens (cluster B1). The beekeepers attended a beekeeping training during the past three years, used an apiarist book, had a qualification in beekeeping, were members of a beekeeping organisation and had an experience in beekeeping superior to five years (cluster D1). The beekeepers applied a cooperative treatment against varroa before the visit. The apiaries experienced all health events before starting the EPILOBEE program (cluster C1) and did not suffer from any disease at the autumn visit (cluster A1).

Cluster F2 (258 apiaries)

The second cluster was composed of hobbyist beekeepers less than 30 years of age. They had a small apiary and operation (cluster E1) with Buckfast, hybrid and *A. m. ligustica* honeybees, located around a farmland environment or around an environment with town and woods. The apiaries were managed by beekeepers with a production including queens (cluster B1). The beekeepers did not attend any beekeeping training during the past three years, did not use any apiarist book, did not have any qualification in beekeeping, were not members of any beekeeping organisation, and had an experience in beekeeping inferior to two years (cluster D2). The *Coop_treat*, *Disease* and *Health_event* variables did not appear in this cluster due to the absence of an over represented category.

Cluster F3 (403 apiaries)

This cluster was composed of hobbyist beekeepers over 65 years of age. They had a small apiary and operation (cluster E1) with Buckfast, hybrid and *A. m. ligustica* honeybees, located around a farmland environment or around an environment with town and woods. The apiaries were managed by beekeepers with a production including queens (cluster B1). The beekeepers did not attend any beekeeping training during the past three years, did not use any apiarist book, did not have any qualification in beekeeping, were not members of a beekeeping organisation, and had an experience in beekeeping between two and five years (cluster D3). The beekeepers were not part of any cooperative treatment against varroa before the visit. The apiaries did not experience any health event before starting the EPILOBEE program (cluster C2) and were suffering from varroosis at the autumn visit (cluster A2).

Cluster F4 (710 apiaries)

This cluster was composed of hobbyist beekeepers between 30 and 45 years of age. The beekeepers had a small apiary and operation (cluster E1) with local bees and *A. m. carnica*, located around a diverse environment. The beekeepers had three kinds of management: Production, Health conditions and Livestock. The apiaries were managed by beekeepers producing only honey (cluster B2). The beekeepers did not attend any beekeeping training during the past three years, did not use any apiarist book, did not have any qualification in beekeeping, were not members of any beekeeping organisation and had an experience in beekeeping between two and five years (cluster D3). The beekeepers were not part of any cooperative treatment against varroa before the visit. The apiaries experienced all health events before starting EPILOBEE program (cluster C1) and did not suffer from any disease at the autumn visit (cluster A1).

Cluster F5 (944 apiaries)

This cluster was composed of part time beekeepers between 45 and 65 years of age with a big apiary and operation (cluster E3) of local and *A. m. carnica* bees, located around a diverse environment. The beekeepers had three kinds of management: Production, Health conditions and Livestock. The apiaries were managed by beekeepers producing only honey (cluster B2). The beekeepers attended a beekeeping training during the past three years, used an apiarist book, had a qualification in beekeeping, were members of a beekeeping organisation and had experience in beekeeping superior to five years (cluster D1). The beekeepers were part of a cooperative treatment against varroa before the visit. The apiaries experienced all health events before starting EPILOBEE program (cluster C1) and did not suffer from any disease at the autumn visit (cluster A1).

Cluster F6 (424 apiaries)

This cluster was composed of part time beekeepers between 45 and 65 years of age. The beekeepers had a medium size apiary and operation (cluster E2) of *A. m. iberiensis* and *A. m. ccm* bees, located around a floral environment. The apiaries migrated. Most of the time crops were targeted (or a diverse environment). The apiary management promoted the increase of the livestock and colonies were merged. The beekeepers did not buy any queen nor swarm and produced more than 10 queens and swarms. The productions were diverse (cluster B3). The beekeepers attended a beekeeping training during the past three years, used an apiarist book, had a qualification in beekeeping, were members of a beekeeping organisation and had an experience in beekeeping superior to five years (cluster D1). The beekeepers were not part of any cooperative treatment against varroa before the visit. The apiaries did not experience any health events before starting the program (cluster C2) and were suffering from AFB and Varroosis at the autumn visit (cluster A1 and A2).

Cluster F7 (695 apiaries)

This cluster was composed of professional beekeepers between 30 and 45 years of age. These beekeepers had a big apiary and operation (cluster E3) with *A. m. iberiensis* and *A. m. ccm* bees, located around a floral environment. The apiaries migrated targeting most of the time crops (or a diverse environment). The apiary management promoted the increase of the livestock and colonies were merged. These beekeepers did not buy any queen nor swarm and produced more than 10 queens and swarms. The productions were diverse (cluster B3). The beekeepers attended a beekeeping training during the past three years, used an apiarist book, had a qualification in beekeeping, were member of a beekeeping organisation, and had an experience in beekeeping superior to five years (cluster D1). The beekeepers were not part of any cooperative treatment against varroa before the visit. The apiaries did not experience any health events before starting the program (cluster C2) and did not suffer from any disease at the autumn visit (cluster A1).

For the seasonal mortality:

The *winter_mortality_class* variable was added to the clusters to account for the mortality during the previous winter.

Cluster F1 (633 apiaries)

This cluster was composed of hobbyist beekeepers over 65 years of age with a small apiary and operation (cluster E1) of Buckfast, hybrid and *A. m. ligustica* honeybees (cluster B1). The beekeepers did not attend any beekeeping training during the past three years and did not use any apiarist book (cluster D4). The beekeepers did not apply any cooperative treatment against varroa before the visit. The apiaries experienced a previous winter mortality rate between 21 % and 50 %. The apiaries did not experience any health events before starting the EPILOBEE program (cluster C2) and were suffering from Varroosis at the spring visit (cluster A3).

Cluster F2 (794 apiaries)

This cluster was composed of hobbyist beekeepers over 65 years of age with a small apiary and operation (cluster E1) with local and *A. m. iberiensis* honeybees. These beekeepers did not merge the

colonies nor buy any swarm nor queens (cluster B2). The beekeepers did not attend any beekeeping training during the past three years and used an apiarist book (cluster D2). The beekeepers were not part of any cooperative treatment against varroa before the visit. The apiaries did not experience any previous winter mortality nor any health events before starting the program (cluster C2) and did not suffer from any disease at the spring visit (cluster A1).

Cluster F3 (1 299 apiaries)

This cluster was composed of hobbyist beekeepers between 45 and 65 years of age with a small apiary and operation (cluster E1) of Buckfast, hybrid and *A. m. ligustica* honeybees (cluster B1). The beekeepers attended a beekeeping training during the past three years and used an apiarist book (cluster D1). The beekeepers were part of a cooperative treatment against varroa before the visit. These apiaries did not experience any previous winter mortality. The apiaries experienced all health events before starting the program (cluster C1) and did not suffer from any disease at the spring visit (cluster A1).

Cluster F4 (103 apiaries)

This cluster was composed of hobbyist beekeepers who did not attend any beekeeping training during the past three years and did not use any apiarist book (cluster D4). The beekeepers were not part of any cooperative treatment against varroa before the visit. The apiaries experienced a previous winter mortality rate between 21 % and 50 %, did not experienced any health event before starting the program (cluster C2) and were suffering from AFB at the spring visit (cluster A3). The *Size*, *Age* and *Management* variables did not appear in this cluster due to the absence of an over represented category.

Cluster F5 (684 apiaries)

This cluster was composed of part-time beekeepers between 45 and 65 years of age with a medium apiary and operation (cluster E2) of *A. m. carnica* and *A. m. ccm* honeybees. These beekeepers produced more than ten queens and swarms, and bought more than ten queens and more than five swarms. Colonies were merged. Beekeepers had three kinds of management: Production, Health conditions and Livestock (cluster B3). The beekeepers attended a beekeeping training during the past three years and used an apiarist book (cluster D1). The beekeepers were part of a cooperative treatment against varroa before the visit. The apiaries experienced a previous winter mortality rate between 6 % and 10 %. The apiaries experienced all health events before starting the program (cluster C1). The *Disease* variable did not appear in this cluster due to the absence of an over represented category.

Cluster F6 (885 apiaries)

This cluster was composed of part-time beekeepers between 30 and 45 years of age. The beekeepers had a medium size apiary and operation (cluster E2). The cluster gathered apiaries of *A. m. carnica* and *A. m. ccm* honeybees. The beekeepers produced more than ten queens and swarms and bought more than ten queens and more than five swarms. Colonies were merged. Beekeepers had three kinds of management: Production, Health conditions and Livestock (cluster B3). They attended a beekeeping training during the past three years and did not used any apiarist book (cluster D3). They were not part of any cooperative treatment against varroa before the visit. The apiaries experienced a previous winter mortality rate between 1 % and 5 %. The apiaries did not experience any health events before starting the program (cluster C2) and were suffering from Varroosis at the spring visit (cluster A3).

Cluster F7 (360 apiaries)

This cluster was composed of professional beekeepers between 30 and 45 years of age with a big size of apiary and operation (cluster E3). The cluster gathered apiaries of *A. m. carnica* and *A. m. ccm* honeybees. The beekeepers produced more than ten queens and swarms and bought more than ten

queens and more than five swarms. Colonies were merged. They had three kinds of management: Production, Health conditions and Livestock (cluster B3). The beekeepers attended a beekeeping training during the past three years and used an apiarist book (cluster D1). The beekeepers were not part of any cooperative treatment against varroa before the visit. The apiaries experienced a previous winter mortality rate between 6 % and 10 %. The apiaries did not experience any health events before starting the EPILOBEE program (cluster C2) and did not suffer from any disease at the spring visit (cluster A1).

Step 5: Winter and seasonal mortalities

This new synthetic variable with 7 categories resulting from the clustering was analysed (as a fixed effect) through a multivariate model with the *Country* and *Program* variables introduced as random effects. One multivariate model was run for winter mortality and another one for seasonal mortality. The results included the data from the first and second years of EPILOBEE.

The multivariate model produced the mortality rate for each cluster. For example, the highest winter mortality rate (14.04 %) was affected to the cluster F3 and the lowest (8.11 %) to the cluster F7 (Table 21). These two clusters were different with regards to the following features:

- on the one hand hobbyist beekeepers over 65 years of age with small apiary and operation located around a farmland environment or around an environment with town and woods. The apiaries were managed by beekeepers with a production including queens. The beekeepers had a small experience in beekeeping (did not attend any beekeeping training, did not use an apiarist book, did not have any qualification, was not a member of any beekeeping organisation, and had an experience in beekeeping between two and five years). The apiaries suffered from varroosisat the autumn visit **(highest winter mortality rate = 14.04%)**

- on the other hand professional beekeepers between 30 and 45 years of age with big apiary and operation, located around a floral environment. The apiaries were migrated targeting crops most of the time (or a diverse environment). The apiary management promoted the increase of the livestock (producing more than ten queens and swarms) and colonies were merged. The productions were diverse. The beekeepers attended a beekeeping training during the past three years, used an apiarist book, had a qualification in beekeeping, was a member of a beekeeping organisation, and had an experience in beekeeping superior to five years. The apiaries did not suffer from any disease at the autumn visit **(lowest winter mortality rate = 8.11%)**

The mortality rate of the cluster F1 (9.50%) was not significantly different from the rate of the cluster F2 (9.74%; p-value = 0.18). The rates of the cluster F3, F4, F5, F6 and F7 were significantly different from each other (Table 21).

Table 21: Winter mortality rates obtained for each cluster produced by the multivariate model for the analysis of EPILOBEE data (2012-2014)

clusters	Winter mortality rate (%)
cluster F1	9.50
cluster F2	9.74
cluster F3	14.04
cluster F4	11.46
cluster F5	8.66
cluster F6	12.67
cluster F7	8.11

For the seasonal mortality, the highest rate (7.81%) was attributed to the cluster F4 and the lowest (1.81%) to the cluster F3 (Table 22). These two clusters were different with regards to the following features:

- on the one hand beekeepers who did not attend any beekeeping training during the past three years and did not use an apiarist book. The beekeepers were not part of any cooperative treatment against varroa before the visit. The apiaries experienced a previous winter mortality rate between 21% and 50%, did not experienced any health event before starting the EPILOBEE program and were suffering from AFB at the spring visit **(highest seasonal mortality rate = 7.81%)**

- on the other hand the beekeepers attended a beekeeping training during the past three years and used an apiarist book. The beekeepers were part of a cooperative treatment against varroa before the visit. These apiaries did not experience any previous winter mortality. All the apiaries experienced some health events before starting the EPILOBEE program and did not suffer from any disease at the spring visit **(lowest seasonal mortality rate = 1.81%).**

The mortality rate of the cluster F5 (2.00%) was not significantly different from the rate of the cluster F7 (2.04%; p-value = 0.48). The rates of the cluster F1, F2, F3, F4 and F6 were significantly different from each other (Table 22).

Table 22: Seasonal mortality rates obtained for each cluster produced by the multivariate model for the analysis of EPILOBEE data (2012-2014)

clusters	Seasonal mortality rate (%)
cluster F1	3.40
cluster F2	2.48
cluster F3	1.81
cluster F4	7.81
cluster F5	2.00
cluster F6	3.98
cluster F7	2.04

The clusters with significant differences in winter mortality involved beekeepers with different ages. It should be noted that the overall apiarist population in Europe has always been elderly especially for hobbyists. It has been largely reported that very few young beekeepers started new operations, particularly in the professional section. This *Age* variable was statistically linked to the size of the apiaries. Elderly beekeepers usually possessed a few honeybee colonies in their backyards as they always had. This tendency should however be nuanced by a new trendy "urban beekeeping" movement rising in Europe and the US, that attracts many new people, who for the majority are still not familiar with all the demands for keeping healthy bees. Usually these new beekeepers have started beekeeping activities lacking basic skills and background knowledge, as it is described in the features of the clusters. The clusters were also different by the fact that some apiaries suffered from AFB and not in the others. This might be related to beekeeping knowledge and the status of the beekeepers. Professional beekeepers rely on the beekeeping activity for their main income (Chauzat, Cauquil, et al. 2013). Therefore, several assumptions could be formulated to explain the better survival of honeybee colonies in these large apiaries: the professionals have better knowledge on beekeeping practices (e.g. preparation of colonies for winter), disease detection and management; they may have applied better and earlier prophylactic measures. The lower mortality rates were also associated with migratory apiaries. It is known that professional beekeepers move their hives more frequently targeting the nectar flows. Indeed, other publications have shown that food resources may lack qualitatively and quantitatively in some areas at some points in the year (reviewed in (Decourtye, Mader, and Desneux 2010)).

In the study conducted for each year of EPILOBEE, the number of swarms bought was linked with both mortalities both years of EPILOBEE with a positive trend (the more swarms were bought, the highest the colony mortality was). The statistical link was also significant between merged colonies and colony losses. This might reflect the additional work needed by a beekeeper to overcome colony losses: beekeepers got new swarms and merged colonies to maintain the livestock at an acceptable level in quantity and quality.

In EPILOBEE, the environment was assessed by the beekeepers and the bee inspectors. It was not accurately measured by a geographical system. Therefore, results should be taken with caution as they might not be really representative of the landscape. Thus, a second step might be to directly investigate the causes of colony losses by conducting specific studies such as case-control studies including analysis on pesticide residues and the recording of the landscape. These factors would be included as potential causes of honeybee losses, alone or with interactions.EPILOBEE being a descriptive epidemiological program, conclusions should not be drawn beyond the limits of the protocol. All the hypotheses formulated here should be fully tested in dedicated experimental protocols to validate the risk factors and clarify any potential causality (Lee et al. 2015).

4. Conclusions

During the first year (2012-2013) of the EPILOBEE survey, the lowest winter mortality rates were recorded in Greece, Lithuania and Italy, and the highest rates in Belgium. Sweden, Hungary, Portugal, Slovakia, Poland, Denmark, Latvia and Lithuania had the lowest seasonal mortality rates. The highest seasonal mortality rates were recorded in France and England and Wales.

During the second year (2013-2014) of the EPILOBEE survey, Lithuania recorded the lowest winter mortality and was statistically separated from all the other Member States. The highest winter mortality was recorded in Belgium, Estonia, Sweden, France and Denmark. Hungary, Estonia, Finland, Slovakia, Latvia, Poland and Lithuania had the lowest seasonal mortality rates while France and Belgium recorded the highest seasonal mortality rates.

For each year of the EPILOBEE survey, the seasonal mortality was statistically linked to the winter mortality. This means that when the colony mortality rate was high during the winter, the colony mortality rate tended to be high during the subsequent summer. Between years, winter and seasonal mortalities varied widely among Member States. In the multivariate Poisson regression models combining both years, the country was studied as a random effect. The age, apiary size, operation size, beekeeping knowledge and training were found to have a statistically significant effect on the mortality of honeybee colonies during the winter and the beekeeping season in Europe in 2012-2014.

Using a hierarchical clustering of observations, the highest winter mortality rate (14.04%) was affected to a cluster including hobbyist beekeepers over 65 years of age with a small size apiary, with a production including queens and with a small experience in beekeeping. The apiaries suffered from varroosis at the autumn visit.

The lowest winter mortality rate (8.11%) was affected to a cluster with professional beekeepers between 30 and 45 years of age, with large migrating apiaries. The apiary management promoted the increase of the livestock. These professional beekeepers attended a beekeeping training during the past three years, used an apiarist book, had a qualification in beekeeping, were members of a beekeeping organisation, and had an experience in beekeeping superior to five years. The apiaries did not suffer from any disease at the autumn visit.

The variables with a statistically significant effect on honeybee colony mortality during the beekeeping season in Europe were colonies clinically affected by varroosis, the absence of beekeeping training during the past three years of the beekeeper's activity, the non-use of an apiarist book and the non-participation to a cooperative veterinary treatment.

The statistical significant link between the number of swarms bought and merged colonies, and colony losses might reflect the additional work needed by beekeepers to overcome colony losses: beekeepers got new swarms and merged colonies to maintain the livestock at an acceptable level in quantity and quality.

EPILOBEE was the first EU-wide and voluntary-based initiative from the European Commission aiming at measuring honeybee colony mortality in Europe. The epidemiological study relied on the setting of a new network gathering a dedicated team in each participating Member State. In the framework of EPILOBEE the training of honeybee colonies inspectors was supported and stimulated in a harmonised manner. A large dataset was stored in a web-based database specifically created for the project and accessible by Member States for data reporting. The dataset made possible to handle complex statistical procedures to analyse field data related to beekeeping and honeybee health for the first time.

EPILOBEE being a pilot project was rich in lessons. For future epidemiological surveys, it is recommended to better adapt the protocol to the size of the project. The number of variables collected during the program (138) was too large to all be included in the statistical analysis. Besides the variables were highly correlated between each other. Thus improvement should be applied in data collection by restricting the information collected from the field to the most relevant avoiding redundant variables. The study of some potential risk factors should be specifically targeted through dedicated protocols. EPILOBEE underlines also the necessity to have very specific care in assessing how bee inspector training, networking and data reporting is implemented in Member States. Due to time constraint, the database was developed at the beginning of the field study. However, it is advised to develop the database before data are collected and to design it in a way that data can be self validated and readily analysed. Data models using more controlled terminologies and stricter business rules would have avoided the need for some editing and checking steps that were resource consuming and led to the non inclusion of information collected in the field.

Such a big program required a lot of efforts to be designed and organised in the field. To make the most of large epidemiological surveys, they should last for at least three years to produced results that give a tendency in time. The outcomes of EPILOBEE were an essential prerequisite to the implementation of future explanatory studies investigating the potential causes of honeybee colony losses such as multiple and co-exposure to pesticides (e.g. insecticides, fungicides and acaricides) and their possible interactions with infectious agents.

5. Recommendations

The EPILOBEE initiative gathered and accumulated experience and knowledge that could be transferred and further implemented for future monitoring programs, in particular in the following areas:

- Project management and resources
  - Adapt the protocol to the size of the project. The project was initially designed for a few participating Member States (5 to 7). With more Member States taking part in the project, the protocol should have been simplified to reduce the amount of data collected (e.g. the information requested in the questionnaires). Due to time constraints the modifications were not implemented.
  - Involve statisticians in the design of the protocol and during the data collection to insure consistent data reporting and analysis.
  - Allow enough time and human resources to check the data (see 2.2.2 The population under study) in due time. This will allow Member States to correct any mistakes.

- Protocol design
  - Complete the global objective (initial question) by addressing specific objectives (additional questions) through dedicated protocols. EPILOBEE was designed to assess honeybee colony morality. It was not designed to statistically link *specific* factors with honeybee colony mortality (e.g. subspecies of honeybees, environmental coverage).
  - Address beforehand specific technical issues (e.g. the numbering of colonies during the different years of sampling, the inclusion of new colonies during the course of the project, difficulty for the beekeepers to remember management actions implemented between visits, produce data in a format consistent with the database).
  - Use detailed geographical surveys (e.g. with GIS techniques) for the recording and analysis of the factors related to the environment of the honeybee colonies (e.g. crops, farming practices, pesticide usage, etc.).
  - Use standardised morphometric or molecular techniques to determine the genetic origin of the bees (subspecies level) when assessing the effect of bee breed.
- Networking, bee inspector training and data reporting
  - The number of people to be involved in the project in each Member State should be adapted to the size of the national protocol. Special care should be dedicated to the coordination team. This could be covered by the use of performance indicators.
  - It is recommended to have the same dedicated people during the full length of the program to avoid as much as possible the training of new human resources during the course of the program and to ensure the consistency of the data collection and reporting.
  - Make sure that people who enter the data in the database are well trained and have sufficient knowledge on beekeeping. This could be covered by the use of performance indicators.
- Database
  - The database should be fully implemented before the data collection starts to allow Member States to get familiar with it, to prefill informative fields. Subsequently Member states could make extraction or basic descriptive analyses very early after the field work starts.
  - Information missing (NA) should be distinguished clearly from information not available (0, zero, null) or unknown (information not reported) (see Appendix F2).
  - The apiary being the epidemiological unit, in the database when possible, store the information directly at the apiary level (not at colony level) (see Appendix F2).
  - Store all information in the format adapted for further statistical analysis (group the information, see Appendix C2).

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Glossary and Abbreviations

Glossary

Apiarist book: livestock register where the beekeepers record any relevant information on apiary treatments or beekeeping management.

Apiary: a group of colonies of bees with the same beekeeping management. The apiary is also the place where honeybees are kept. The apiary can be considered as one single epidemiological unit.

Beekeeper: any legal entity or natural person, owner or holder of one or several hives.

Beekeeping operation: total number of honeybee colonies belonging to one beekeeper.

Beekeeping season: lasts from the end of the winter (very early spring) to the end of honey production (late summer or autumn).

Completeness of a variable: evaluation of missing data in a variable.

Drone layer queen: a queen that can lay only unfertilised eggs which develop into drones.

Honeybee: a social domestic honey producing bee (*Apis mellifera* ssp.).

Honeybee colony: group of honeybees having a queen, some thousands of workers, and during part of the year a number of drones, reared in order to produce honey or other beekeeping products.

Hive: habitat unit of one honeybee colony furnished by the beekeeper.

Not available (NA): missing values are replaced by NA.

Swarm: the aggregate of worker bees, drones and one queen that leave the mother colony to establish a new colony. Swarming is the natural method of propagation of the honeybee colony. Swarms can be produced by the beekeeper.

Abbreviations

ABPV	Acute Bee Paralysis Virus
AFB	American Foulbrood
ANSES	Agence Nationale de Sécurité Sanaitaire
A. m.	Apis melifera
BE	Belgium
CBPV	Chronic Bee Paralysis Virus
ccm	carpatica caucasia macedonia
DE	Germany
DK	Denmark
DWV	Deformed Wing Virus
EFB	European Foulbrood
EE	Estonia
EN & WA	England and Wales
ES	Spain
EPILOBEE	The **epi**demiolgical study on honey**bee lo**ses in Europe

EURL	European Reference Laboratory
FI	Finland
FR	France
GR	Greece
HCPC	Hierarchical Clustering on Principle Components
HU	Hungary
IT	Italy
LR	Likelihood ratio
LV	Latvia
LT	Lithuania
MCA	Multiple Correpondance Analysis
MS	Member state
NA	Not available
NUTS	Nomenclature of Territorials Unit for Statisctics
PL	Poland
PT	Portugal
SE	Sweden
SL	Slovakia
V1	Autumn visit
V2	Spring visit
V3	Summer visit

Appendix A – Field questionnaire

EPILOBEE: Study on the surveillance of honeybee colony losses 2013-2014

Visit 1 before the wintering period

Visit carried out by*: ……

Date (DD/MM/YYYY) *: ……/……/……

Number of colonies inspected*: ……..

Please fill in all mandatory fields indicated with an asterisk *. Please note that any requested information mentioned in blue is optional.

GENERAL INFORMATION ON THE BEEKEEPER AND THE APIARY VISITED:

1/ Beekeeper

SURNAME (Last name) *: ……

Forename (First name)*: ……

Address*: ……

Zipcode*: …… City*:

……

Tel: …….. E-mail: ……

Beekeeper's national identification number *: ……

Beekeeper:

☐ Professional (the beekeeping activity is the only source of income and/or the beekeeper owns more than 150 colonies)

☐ Part-time (the beekeeping activity is a source of income but not the only one)

☐ Hobby

Total number of colonies belonging to the beekeeper*: ……..

Total number of apiaries belonging to the beekeeper*: ……..

2/ Apiary visited

Location:

Zipcode*: …… Name of the municipality/area/village/Parish*: ……

Locality*: ……

GPS (6 decimals) : Latitude: …… - Longitude: …… (eg: 43.612454 -7.054878)

Date of the installation of the colonies on the apiary: .....

Seasonal migration apiary: ☐ Yes ☐ No

If yes, specify the seasonal migration in 2013:

Dates	Place	Flowering type targeted[1]

[1] Acacia / Beans / Chesnut tree / Clover / Heather / Honeydew / Lavander / Lime / Orange / Orchards / Rapeseed / Raspberry / Seed production / Sunflower / Other (specify)

Number of colonies in the apiary*: .....

Breed of honeybees: .....

Targeted production:

- ☐ Honey
- ☐ Pollen
- ☐ Royal jelly
- ☐ Queens
- ☐ Swarms
- ☐ Pollination Services

Introduction of queens in 2013 in the apiary: ☐ Yes ☐ No

If yes, specify the country(ies) of origin: .....

Introduction of honeybees / swarms in the apiary: ☐ Yes ☐ No

If yes, specify the country(ies) of origin: .....

Environment of the apiary (within a radius of 3 km):

- ☐ Farmlands, type: .....
- ☐ Orchards, please specify the species: .....
- ☐ Wild natural flora
- ☐ Forest, wood
- ☐ Towns
- ☐ Industries, motorways, other: .....

Estimated number of other apiaries in close vicinity (3 km): .....

3/ Risk factor for exotic arthropod introduction (please tick the box):

- ☐ Queen import
- ☐ Vicinity of an international harbor (less than 10 km)
- ☐ Vicinity of an international airport (less than 10 km)
- ☐ Other (please, specify)

4/ Livestock management: actions since the last visit

Specify the livestock management performed during the winter 2012-2013:

Date of these actions (MM/YYYY): ……/……

The objectives of these actions are:

- ☐ **to maintain the livestock**
- ☐ **to increase the livestock**
- ☐ **to increase the production**
- ☐ **to improve the health conditions**

Number of swarms or colonies introduced in this apiary:

- Bought*: …… (Please, specify the country(ies) of origin: ……)
- Produced by the beekeeper*: ……

Number of queens alone introduced in this apiary:

- Bought*: …… (Please, specify the country(ies) of origin: ……)
- Produced by the beekeeper*: ……

Number of colonies that have swarmed or that have been divided or merged in this apiary:

- Divided by the beekeeper*: ……
- Naturally swarmed *: ……

Merged*: ……

5/ Description of health events / disorders observed in the apiary during the season of honey production 2013

Specify the diseases and disorders observed during the season 2013:

Diseases / disorders observed	Description / disease suspected	% of affected colonies	Lab analysis? *if yes, please tick the box*	Conclusion of the analysis	Treatment/sanitary measures
☐ High rate of colony mortality			☐		
☐ High rate of honeybee mortality			☐		

6/ Treatments implemented (including chemical and soft treatments)

What types of treatments are performed?

☐ **Chemical treatments**

☐ **Soft or husbandry treatments**

Please specify each treatment implemented since the last visit.

Dates (DD/MM/YYYY)	Commercial name (specify "soft treatment" in case of husbandry treatment)	Active ingredient(s) or name of measure (e.g. "drone brood removal")	Posology or quantify the measure (e.g. number of frames of drone brood removed)	Duration (in days)	Frequency (per months)	Treatment correctly applied

Is there an apiarist book / a register for the operation? ☐ Yes ☐ No

INVESTIGATIONS ON THE COLONIES

Number of colonies inspected:

- **number of colonies randomly selected*** = ...

*Reminder: **y** colonies are randomly selected per apiary. If the number of colonies in the apiary is less than **y**, all the colonies must be inspected.*

Clinical signs and disorders observed:

Please complete the descriptive table with :

« 1 » = yes there is clinical sign and/or disorder observed,

« 0 » = no clinical sign and/or disorder observed.

Reminder: samples to perform:

- **On symptomatic brood: a piece of 10x10 cm of symptomatic brood containing at least 10 to 15 symptomatic cells , nymphs or larvae**

- **On symptomatic honeybees: at least 20 symptomatic honeybees**

INVESTIGATION ON THE RANDOMLY SELECTED COLONIES

Clinical signs/ disorders	Colony number in the random sample											
	1	2	3	4	5	6	7	8	9	10	11	12
Colony identification												
Strength of the colony: from 1-very weak to 5-very strong												
EXTERNAL OBSERVATION(S)												
Dead honeybees in front of the hive												
Crawling honeybees, bees clinging to the grass												
Traces of diarrhea												
Trembling honeybees												
Black shiny honeybees rejected from the hive												
Occupied flight board												
INTERNAL OBSERVATION(S)												
"Spotty" brood pattern												
Ropy larvae												
Specific odor of AFB												
Slumped larvae												
Larvae with a yellowish to brown colour												
Honeybees with deformed and/or atrophied wings												
Phoretic Varroa												
Dead honeybees within cells												
Cannibalism on larvae or on pupae												
Phoretic beetles, unusual larvae or eggs												

Clinical signs/ disorders	Colony number in the random sample											
	1	2	3	4	5	6	7	8	9	10	11	12
Colony identification												
Strength of the colony: from 1-very weak to 5-very strong												
Galleries inside the frames												
Brood and honey destruction												
Suspect atypical mites												
SUSPICIONS*												
Varroosis	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
American Foulbrood	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
European Foulbrood	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Nosemosis	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Chronic paralysis	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Small Hive Beetle	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Tropilaelaps spp	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Dead colony	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other (please, specify)												

INVESTIGATION ON THE RANDOMLY SELECTED COLONIES

Clinical signs/ disorders	Colony number in the random sample											
	13	14	15	16	17	18	19	20	21	22	23	24
Colony identification												
Strength of the colony: from 1-very weak to 5-very strong												
EXTERNAL OBSERVATION(S)												
Dead honeybees in front of the hive												
Crawling honeybees, bees clinging to the grass												
Traces of diarrhea												
Trembling honeybees												
Black shiny honeybees rejected from the hive												
Occupied flight board												
INTERNAL OBSERVATION(S)												
"Spotty" brood pattern												
Ropy larvae												
Specific odor of AFB												
Slumped larvae												
Larvae with a yellowish to brown colour												
Honeybees with deformed and/or atrophied												

Clinical signs/ disorders	Colony number in the random sample											
	13	14	15	16	17	18	19	20	21	22	23	24
Colony identification												
Strength of the colony: from 1-very weak to 5-very strong												
wings												
Phoretic Varroa												
Dead honeybees within cells												
Cannibalism on larvae or on pupae												
Phoretic beetles, unusual larvae or eggs												
Galleries inside the frames												
Brood and honey destruction												
Suspect atypical mites												
SUSPICIONS*												
Varroosis……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
American Foulbrood ……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
European Foulbrood……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Nosemosis……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Chronic	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
paralysis……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Small Hive	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Beetle……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Tropilaelaps	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
spp……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Dead colony……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other (please, specify)……												

INVESTIGATION ON THE EXTRA COLONIES PRESENTING CLINICAL SIGNS

Clinical signs/ disorders	Colony number in the additional sample											
	1	2	3	4	5	6	7	8	9	10	11	12
Colony identification												
Strength of the colony: from 1-very weak to 5-very strong												
EXTERNAL OBSERVATION(S)												
Dead honeybees in front of the hive												
Crawling honeybees, bees clinging to the grass												
Traces of diarrhea												
Trembling honeybees												
Black shiny honeybees rejected from the hive												
Occupied flight board												
INTERNAL OBSERVATION(S)												
"Spotty" brood pattern												
Ropy larvae												
Specific odor of AFB												
Slumped larvae												
Larvae with a yellowish to brown colour												
Honeybees with deformed and/or atrophied wings												
Phoretic Varroa												
Dead honeybees within cells												
Cannibalism on larvae or on pupae												

Clinical signs/ disorders	Colony number in the additional sample											
	1	2	3	4	5	6	7	8	9	10	11	12
Colony identification												
Strength of the colony: from 1-very weak to 5-very strong												
Phoretic beetles, unusual larvae or eggs												
Galleries inside the frames												
Brood and honey destruction												
Suspect atypical mites												
SUSPICIONS*												
Varroosis……												
American Foulbrood ……												
European Foulbrood……												
Nosemosis……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Chronic	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
paralysis……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Small Hive	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Beetle……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Tropilaelaps	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
spp……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Dead colony……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other (please, specify)……												

INVESTIGATION ON THE EXTRA COLONIES PRESENTING CLINICAL SIGNS

Clinical signs/ disorders	Colony number in the additional sample											
	13	**14**	15	16	17	18	19	20	21	**22**	23	**24**
Colony identification												
Strength of the colony: from 1-very weak to 5-very strong												
EXTERNAL OBSERVATION(S)												
Dead honeybees in front of the hive												
Crawling honeybees, bees clinging to the grass												
Traces of diarrhea												
Trembling honeybees												
Black shiny honeybees rejected from the hive												
Occupied flight board												
INTERNAL OBSERVATION(S)												
"Spotty" brood pattern												
Ropy larvae												
Specific odor of AFB												
Slumped larvae												
Larvae with a yellowish to brown colour												
Honeybees with deformed and/or atrophied wings												
Phoretic Varroa												
Dead honeybees within cells												
Cannibalism on larvae or on pupae												

Clinical signs/ disorders	Colony number in the additional sample											
	13	**14**	15	16	17	18	19	20	21	**22**	23	**24**
Colony identification												
Strength of the colony: from 1-very weak to 5-very strong												
Phoretic beetles, unusual larvae or eggs												
Galleries inside the frames												
Brood and honey destruction												
Suspect atypical mites												
SUSPICIONS*												
Varroosis……												
American Foulbrood ……												
European Foulbrood……												
Nosemosis……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Chronic	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
paralysis……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Small Hive	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Beetle……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Tropilaelaps	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
spp……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Dead colony……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other (please, specify)……												

SAMPLES COLLECTED:

Symptomatic honeybees (20 per sample)

Please distinguish dead bees from living symptomatic honeybees.

Identification of the samples:

Beekeeper number / A13 (for Autumn 2013) / N° of the colony / Matrix + Number (= 1, 2,3…)

Matrix abbreviations: Honeybees = HB, Brood = BR, Parasite = PAR, Systematic honeybee sample: SYS

E.g. : 26001926/A13/7/HB1

Remark: if several apiaries belong to the same beekeeper, each apiary will be identified with a hundred added to the number of the colony

*E.g.:26001926/A13/**1**07/HB1*

*26001926/A13/**2**07/HB1*

Individual apiary number / A13 / N° of the colony / Matrix + Number

Sample identification	Internal laboratory identification	Nature of the sample		Suspected diseases			
		Living external honeybees	Dead honeybees	VARROOSIS	NOSEMOSIS	CHRONIC PARALYSIS	Other specify
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	

Sample identification	Internal laboratory identification	Nature of the sample		Suspected diseases			
		Living external honeybees	Dead honeybees	VARROOSIS	NOSEMOSIS	CHRONIC PARALYSIS	Other specify
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	

Sample identification	Internal laboratory identification	Nature of the sample		Suspected diseases			
		Living external honeybees	Dead honeybees	VARROOSIS	NOSEMOSIS	CHRONIC PARALYSIS	Other specify
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	

Symptomatic brood

Sample identification	Internal laboratory identification	Nature of the sample		Diseases suspected			
		Piece of brood (frame)	Larvae, nymphs, scales…	VARROOSIS	AMERICAN FOULBROOD	EUROPEAN FOULBROOD	Other specify
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	

Sample identification	Internal laboratory identification	Nature of the sample		Diseases suspected			
		Piece of brood (frame)	Larvae, nymphs, scales…	VARROOSIS	AMERICAN FOULBROOD	EUROPEAN FOULBROOD	Other specify
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	

Suspect parasites

Please collect samples in case of any observations of suspect parasites (hive beetles or mites different from varroa).

Sample identification	Internal laboratory identification	Nature of the sample			Complementary information (if necessary)
		Beetle larva	Beetles	Mites	
		☐	☐	☐	
		☐	☐	☐	
		☐	☐	☐	
		☐	☐	☐	
		☐	☐	☐	

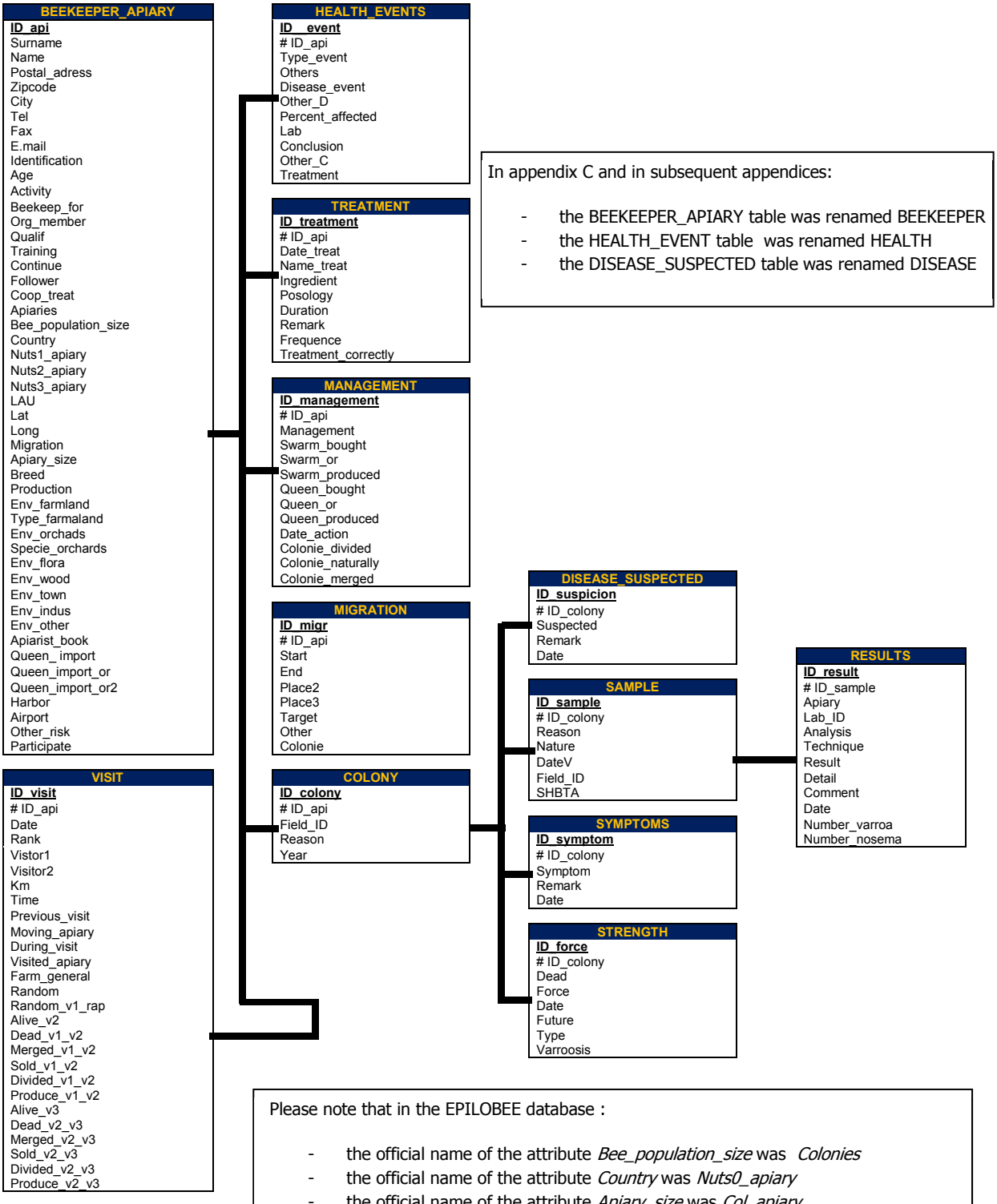
Sample identification	Internal laboratory identification	Nature of the sample			Complementary information (if necessary)
		Beetle larva	Beetles	Mites	
		☐	☐	☐	
		☐	☐	☐	
		☐	☐	☐	

Place of sample storage:

……

……

Appendix B – Structure of the EPILOBEE database



In appendix C and in subsequent appendices:

- the BEEKEEPER_APIARY table was renamed BEEKEEPER
- the HEALTH_EVENT table was renamed HEALTH
- the DISEASE_SUSPECTED table was renamed DISEASE

Please note that in the EPILOBEE database :

- the official name of the attribute *Bee_population_size* was *Colonies*
- the official name of the attribute *Country* was *Nuts0_apiary*
- the official name of the attribute *Apiary_size* was *Col_apiary*
- the official name of the attribute *Management* was *Objective*

BEEKEEPER_APIARY Table

Each line in this table was related to one apiary. Information included in the table concerned the apiary environment, the honeybee breed, the number of colonies in the apiary, the localisation of the apiary, the information related to the beekeeper (name, surname, age or activity).

HEALTH_EVENTS Table

Each line in this table was related to health event that occurred in the apiary before the first visit (Autumn 2012). Some information such as the type of event or disease was reported in this table.

TREATMENT Table

Each line in this table was related to a treatment applied to an apiary. The name of the treatment, the ingredient of the treatment, the posology applied, the date of the treatment were stored in this table.

MANAGEMENT Table

Each line in this table was related to a management operation implemented by a beekeeper on the apiary. For example, the main management objective, the number of queens/swarms produced and the number of queens/swarms bought were reported in this table.

MIGRATION Table

Each line in this table was related to an organised migration for a given apiary. Information on the type of nectar flows targeted, the migration place or the period of time was reported in this table.

COLONY Table

Each line in this table was related to one colony belonging to an apiary. Information on the reason for the selection of a given colony (randomly selected or not) was reported in this table.

VISIT Table

Each line in this table presents a visit implemented for the selected apiaries. Information on the date of the visit (e.g. autumn visit, spring visit, summer visit) was reported in this table. This table also stored information on the number of colonies randomly selected in autumn and the number of colonies dead, alive or sold after the winter (spring visit) or during the season (summer visit).

DISEASE_SUSPECTED Table

Each line in this table was related to a suspected disease for a given colony at a given date.

SAMPLE Table

Each line in this table was related to a sample taken from a given colony. The reason for the sampling (e.g. systematic sample or symptomatic sample) and the date of the sampling appeared in this table. Systematic samples were collected during autumn visits to assess varroa parasitic pressure. Symptomatic samples were collected during any visits if any clinica signs were observed in colonies

SYMPTOMS Table

Each line in this table was related to a symptom observed in a given colony diro,g a given visit.

STRENGTH Table

Each line in this table was related to the information on the condition and status of a given colony at each visit: information on the date of the visit, whether the colony was dead or not, the strength of the colony, whether a diagnosis for varroosis was performed in the field or not.

RESULTS Table

Each line in this table was related to each laboratory result for a given sample. The following information was stored in this table: the disease for which the sample was analysed, the result of the analysis (e.g. positive or negative) and the technique used. Details and remarks could be added if needed.

Appendix C – Data dictionary EPILOBEE

C1 : Definition of the EPILOBEE variables

Please refer to the Appendix E3 to get the content of each variable.

BEEKEEPER table

	Variables	Definitions
1	**Surname**	Surname of the beekeeper.
2	**Name**	Name of the beekeeper.
3	**Postal_adress**	Postal adress of the beekeeper home.
4	**Zipcode**	Zip code of the beekeeper home.
5	**City**	City of the beekeeper home.
6	**Tel**	Phone number of the beekeeper.
7	**Fax**	Fax number of the beekeeper.
8	**E.mail**	E-mail address of the beekeeper.
9	**Identification**	National identification of the beekeeper.
10	**Age**	Age of the beekeeper.
11	**Activity**	Typology of the beekeeper activity.
12	**Beekeep_for**	Years of experience of the beekeeper in beekeeping.
13	**Org_member**	Was the beekeeper member of a regional / national beekeeping organization?
14	**Qualif**	Did the beekeeper have any formal qualification in beekeeping?
15	**Training**	Has the beekeeper attended any beekeeping and/or bee health training in the last 3 years?
16	**Continue**	Did the beekeeper plan to continue his / her bee activity for more than 2 years?
17	**Follower**	In case the beekeeper planned to leave his/her apiary, was anybody likely to take over his/her apiary?
18	**Coop_treat**	Was the beekeeper part of a cooperative treatment against varroa with neighboring beekeepers?
19	**Apiaries**	Total number of apiaries owned by the beekeeper.
20	**Bee_population_size**	Total number of colonies owned by the beekeeper.
21	**Country**	Country where the apiary was located.
22	**Nuts1_apiary**	Regional division (at the Nuts 1 level) where the apiary was located.
23	**Nuts2_apiary**	Regional division (at the Nuts 2 level) where the apiary was located.
24	**Nuts3_apiary**	Regional division (at the Nuts 3 level) where the apiary was located.
25	**LAU**	Local Administrative Unit where the apiary was located.
26	**Lat**	Latitude of the apiary location.
27	**Long**	Longitude of the apiary location.
28	**Migration**	Did the apiary migrate at least one time during the past seasonal period , before the winter period of after the winter period?
29	**Apiary_size**	Total number of colonies in the apiary randomly selected.
30	**Breed**	Which was the honeybee strains/subspecies of honeybees in the apiary?
31	**Production**	Production targeted by the beekeeper.
32	**Env_farmland**	Was there a farmland environment surrounding the apiary?
33	**Type_farmland**	Type of the farmland environment surrounding the apiary.
34	**Env_orchads**	Was there an orchards' environment surrounding the apiary?
35	**Specie_orchards**	Specie of orchards surrounding the apiary.
36	**Env_flora**	Was there a floral environment surrounding the apiary?
37	**Env_wood**	Was there a wooded environment surrounding the apiary?
38	**Env_town**	Was there an urban environment surrounding the apiary?
39	**Env_indus**	Was there an industrial environment surrounding the apiary?
40	**Env_other**	Was there another environment surrounding the apiary?
41	**Apiarist_book**	Had the beekeeper an apiarist book?
42	**Queen_import**	Was the queen imported from outside of Europe?
43	**Queen_import_or**	Country of origin of the queen
44	**Queen_import_or2**	Second country of origin of the queen
45	**Harbor**	Was the apiary located near an international harbor?
46	**Airport**	Was the apiary located near an international airport?
47	**Other_risk**	Another risk that could have affected the apiary.
48	**Participate**	Did the beekeeper participate in EPILOBEE second year?

COLONY table

	Variables	Definitions
49	**Field_ID**	Field identification of the selected colonies.
50	**Reason**	Whether the colony was randomly selected or part of extra sampling.
51	**Year**	Year of the EPILOBEE program.

DISEASE table

	Variables	Definitions
52	**Suspected**	The disease suspected on the field by the bee inspector.
53	**Remark**	Remark on the disease suspected.
54	**Date**	Date of the visit.

HEALTH table

	Variables	Definitions
55	**Type_event**	Which type of event was experienced in the apiary before the first visit of EPILOBEE program?
56	**Other**	Other types of event than the ones listed that were experienced in the apiary before the first visit of EPILOBEE program.
57	**Disease_event**	Which disease was suspected for the event experienced in the apiary before the first visit of EPILOBEE program?
58	**Other_D**	Other disease than the ones listed that was suspected for the event experienced in the apiary before the first visit of EPILOBEE program.
59	**Percent_affected**	Percentage of the colonies affected by the event.
60	**Lab**	Were laboratory analyses performed?
61	**Conclusion**	Results of the laboratory analyses on the disease affecting the apiary.
62	**Other_C**	Other results of the laboratory analyses than the ones listed .
63	**Treatment**	Treatment/sanitary measures applied to the apiary

MANAGEMENT table

	Variables	Definitions
64	**Management**	Main management objective of the beekeeper.
65	**Swarm_bought**	Number of swarm(s) bought by the beekeeper.
66	**Swarm_or**	Country of origin of the swarm(s) bought.
67	**Swarm_produced**	Number of swarm(s) produced by the beekeeper.
68	**Queen_bought**	Number of queen(s) bought by the beekeeper.
69	**Queen_or**	Country of origin of the queen(s) bought.
70	**Queen_produced**	Number of queen(s) produced by the beekeeper.
71	**Date_action**	Date of the actions of management
72	**Colonie_divided**	Number of colonies divided by the beekeeper in the apiary.
73	**Colonie_naturally**	Number of colonies that have naturally swarmed.
74	**Colonie_merged**	Number of colonies merged by the beekeeper in the apiary.

MIGRATION table

	Variables	Definitions
75	**Start**	Date for the start of the migration.
76	**End**	Date for the end of migration.
77	**Place2**	Regional division (at the Nuts 2 level) where the apiary was migrated.
78	**Place3**	Regional division (at the Nuts 3 level) where the apiary was migrated.
79	**MidSeason_Target**	What kind of nectar flow was targeted by the beekeeper during the past seasonal period?
80	**Other**	Other nectar flow than the ones listed targeted by the beekeeper during the past seasonal period
81	**colonie**	Percentage of the colonies that migrated.

RESULTS table

	Variables	Definitions
82	**Apiary**	Was it an analysis for the whole apiary?
83	**Lab_ID**	Laboratory identification of the analyses.
84	**Analysis**	Disease targeted
85	**Technique**	Analytical technique used.
86	**Result**	Result of the analysis.
87	**Detail**	Details related to the result of the analysis.
88	**Comment**	Comments related to the result of the analysis.
89	**Date**	Date of the analysis.
90	**Number_varroa**	Number of varroa per 100 bees.
91	**Number_nosema**	Number of Nosema spores per bee.

SAMPLE table

	Variables	Definitions
92	**Reason**	Type of sampling.
93	**Nature**	Nature of the sample.
94	**DateV**	Date of the visit.
95	**Field_ID**	Field identification of the samples.

STRENGTH table

	Variables	Definitions
96	**Dead**	Was the colony dead?
97	**Force**	Strength of the colony (From 1-very weak to 5-very strong).
98	**Date**	Date of the visit.
99	**Future**	Other event explaining why the colony was not in the apiary anymore during the visit?
100	**Type**	Whether the colony was randomly selected or part of extra sampling
101	**Varroosis**	Was varroosis observed/diagnosed on the field?

SYMPTOM table

	Variables	Definitions
102	**Symptom**	Symptoms observed on the field.
103	**Remark**	Remark on the symptoms observed
104	**Date**	Date of the visit.

TREATMENT table

	Variables	Definitions
105	**Date_treat**	Date of the treatment.
106	**Name_treat**	Commercial name of the treatment.
107	**Ingredient**	Active ingredient composing the treatment.
108	**Posology**	Dose rate of the treatment.
109	**Duration**	Duration of the treatment (in days).
110	**Remark**	Remark on the treatment.
111	**Frequence**	Frequency of the treatment (in weeks).
112	**Treatment_correctly**	Was the treatment was correctly applied ?

VISIT table

	Variables	Definitions
113	**Date**	Date of the visit.
114	**Rank**	Rank of the visit.
115	**Inspected**	Number of colonies inspected.
116	**Visitor1**	Surname of the bee inspector #1.
117	**Visitor2**	Surname of the bee inspector #2.

118	**Km**	Number of kilometers covered for the visit.
119	**Time**	Number of hours spent to visit the apiary.
120	**Random**	Number of colonies randomly selected at autumn visit.[a]
121	**Random_v1_rap**	Reminder of the number of colonies randomly selected at autumn visit.[b]
122	**Alive_v2**	Number of colonies still alive at spring visit.[b]
123	**Dead_v1_v2**	Number of dead colonies between the autumn and spring visits.[b]
124	**Merged_v1_v2**	Number of merged colonies between the autumn and spring visits.[b]
125	**sold_v1_v2**	Number of sold colonies between the autumn and spring visits.[b]
126	**Divided_v1_v2**	Number of divided colonies between the autumn and spring visits.[b]
127	**Alive_v3**	Number of colonies still alive at summer visit.[c]
128	**Dead_v2_v3**	Number of dead colonies between the spring and summer visits.[c]
129	**Merged_v2_v3**	Number of merged colonies between the spring and summer visits.[c]
130	**sold_v2_v3**	Number of sold colonies between the spring and summer visits.[c]
131	**Divided_v2_v3**	Number of divided colonies between the spring and summer visits.[c]
132	**Previous_visit**	Was the apiary located at the same place as the previous visit?
133	**Moving_apiary**	In case the apiary was moved since the previous visit, reasons of moving the apiary
134	**During_visit**	Total number of colonies in the apiary randomly selected during the visit.
135	**Visited_apiary**	Colony mortality rate according to the beekeeper since the last visit, in the apiary visited.
136	**Farm_general**	Colony mortality rate according to the beekeeper since the last visit, in her/his livestock in general.
137	**Produce_v1_v2**	Number of colonies divided (used to produce one or several swarm(s))between the autumn and spring visits.[b]
138	**Produce_v2_v3**	Number of colonies divided (used to produce one or several swarm(s)) between the spring and summer visits.[c]

(a) To be reported in the autumn visit section of the VISIT table.
(b) To be reported in the spring visit section of the VISIT table.
(c) To be reported in the summer visit section of the VISIT table.

C2 : New categories created to cleanse the EPILOBEE data base

BEEKEEPER table

Variables	Categories stored in the database	New categories
Age	Less than 30	Less than 30
	< 30	
	Meno di 30	
	30-45	30-45
	30 - 45	
	\'30-45\'	
	\\'30-45\\'	
	45-65	45-65
	\'\'45-65\'\'	
	\\'\\'45-65\\'\\'	
	Over 65	Over 65
	> 65	
	Plus de 65	
	\'Over 65\'	
	\\'Over 65\\'	
	\\'\\'\\'\\'Over 65\\'\\'\\'\\'	
	data missing	NA
	Unknown, data missing	
	Inconnus, données manquantes	
Activity	Part-time	Part-time
	Part-Time	
	À temps partiel	
	A tempo parziale	
	Professional	Professional
	Profesional	
	Professionnel	
	Professionista	
	Hobby	Hobby
	\'Hobby\'	
	\\'Hobby\\'	
	\\'\\'\\'\\'Hobby\\'\\'\\'\\'	
	Unknown, data missing	NA
Beekeep_for	Less than 2 years	Less than 2 years
	<2 years	
	2-5 years	2-5 years
	2-5 ans	
	2-5 anni	
	02-mai	
	\'2-5 years\'	
	\'\'2-5 years\'\'	
	\\'2-5 years\\'	
	\\'\\'2-5 years\\'\\'	
	More than 5 years	More than 5 years
	>5	
	Plus de 5 ans	
	Più di 5 anni	
	\'More than 5 years\'	
	\\'More than 5 years\\'	
	data missing	NA
	Unknown, data missing	
	Inconnus, données manquantes	
	Inconnus, donnï¿½es manquantes	
Qualif	Yes	Yes
	Oui	

	No	No
	Aucun	
	Non	
	\'No\'	
	\\'No\\'	
	\'\'No\'\'	
	\\'\\'No\\'\\'	
	\\'\\'\\'\\'No\\'\\'\\'\\'	
	Unknown, data missing	NA
Training	Yes	Yes
	Oui	
	\'\'Yes\'\'	
	\\'\\'Yes\\'\\'	
	No	No
	Non	
	\'No\'	
	\\'No\\'	
	\\'\\'\\'\\'No\\'\\'\\'\\'	
	Unknown, data missing	NA
Coop_treat	Yes	Yes
	Oui	
	\\'\\'\\'\\'Yes\\'\\'\\'\\'	
	No	No
	Non	
	\'No\'	
	\'\'No\'\'	
	\\'No\\'	
	\\'\\'No\\'\\'	
	Unknown, data missing	NA
Country	Belgium	BELGIUM
	BELGIQUE-BELGIË	
	DANMARK	DENMARK
	EESTI	ESTONIA
	UNITED KINGDOM	ENGLAND AND WALES
	SUOMI / FINLAND	FINLAND
	SUOMI	
	FRANCEE	FRANCEE
	DEUTSCHLAND	GERMANY
	GR	GREECE
	MAGYARORSZÁG	HUNGARY
	ITALIA	ITALY
	Abruzzo	
	Campania	
	Emilia-Romagna	
	Friuli-Venezia Giulia	
	Lombardia	
	Sicilia	
	Provincia Autonoma di Bol	
	Liguria	
	LATVIJA	LATVIA
	LIETUVA	LITHUANIA
	POLSKA	POLAND
	PORTUGALL	PORTUGALL
	SLOVENSKO	SLOVAKIA
	SVERIGE	SWEDEN
Production	Honey	Only honey

	Honey;	
	Pollen	Includes pollen production
	Honey + Pollen	
	Honey,Pollen	
	Honey; Pollen;	
	Pollination service	Includes pollination Services
	Pollination service;	
	Pollination Services	
	Honey,Pollination Services	
	Honey; Pollination service;	
	Honey,Pollen,Pollination Services	
	Honey,Queens,Pollination Services	
	Honey; Swarms; Pollination service;	
	Honey,Pollen,Queens,Pollination Services	
	Honey,Pollen,Swarms,Pollination Services	
	Honey,Queens,Pollination Services,Swarms	
	Honey,Pollen,Royal jelly,Queens,Swarms,Pollination	
	Queens	Includes queens production
	Honey + Queens	
	Honey,Queens	
	Royal jelly	Includes royal jelly production
	Honey + Royall jelly	
	Honey + Royal jelly	
	Honey,Royal jelly	
	Honey; Royal jelly;	
	Swarms	Includes swarms production
	Swarms;	
	Honey + Swarms	
	Honey,Swarms	
	Honey; Swarms;	
	Swarms,Honey	
	Queens,Swarms	Other
	Queens; Swarms;	
	Honey,Pollen,Queens	
	Honey,Pollen,Royal jelly	
	Honey,Royal jelly,Pollen	
	Honey,Pollen,Swarms	
	Honey; Pollen; Swarms;	
	Honey,Queens,Swarms	
	Honey; Queens; Swarms;	
	Honey,Royal jelly,Queens	
	Honey,Royal jelly,Swarms	
	Honey,Pollen,Royal jelly,Queens	
	Honey,Pollen,Queens,Swarms	
	Honey; Pollen; Queens; Swarms;	
	Honey,Pollen,Royal jelly,Swarms	
	Honey,Royal jelly,Queens,Swarms	
	Honey,Pollen,Royal jelly,Queens,Swarms	
	on	NA
	on,on	
Apiarist_book	Yes	Yes
	Oui	
	\\'Yes\\'	
	\\'\\'\\'\\'Yes\\'\\'\\'\\'	
	No	No
	Non	
	\\'No\\'	
	\\'\\'No\\'\\'	
		NA
Queen_import	Yes	Yes
	No	No
	Aucun	

	Non	
	\\'No\\'	
	\\'\\'No\\'\\'	
	\\'\\'\\'\\'No\\'\\'\\'\\'	
	Unknown, data missing	NA
	Inconnu, données manquantes	
	Inconnus, données manquantes	
	Sconosciuti, i dati mancanti	
	Sconosciuti, i Dati mancanti	
Org_member	Yes	Yes
	Oui	
	Sì	
	\\'Yes\\'	
	No	No
	Non	
	\\'\\'No\\'\\'	
	\\'\\'\\'\\'No\\'\\'\\'\\'	
	Unknown, data missing	NA
Continue	Yes	Yes
	Oui	
	Sì	
	\\'Yes\\'	
	\\'\\'Yes\\'\\'	
	\\'\\'\\'\\'Yes\\'\\'\\'\\'	
	No	No
	Unknown, data missing	NA
	data missing	
	Inconnus, données manquantes	
Breed	A. cerana	A. cerana
	A. m. carnica	A. m. carnica
	A. m. carpatica	A. m. ccm
	A. m. caucasica	
	A. m. macedonica	
	A. m. iberiensis	A. m. iberiensis
	A. m. ligustica	A. m. ligustica
	A. m. mellifera	A. m. mellifera
	A.m.mellifera + Buckfast	Buckfast
	Buckfast + A.m.carnica	
	Buckfast	
	Local bees	Local bees
	\\'Local bees\\'	
	\\'\\'Local bees\\'\\'	
	\\'\\'\\'\\'Local bees\\'\\'\\'\\'	
	Abeilles locales	
	\\'Abeilles Local\\'	
	Hybrid	Hybrid
	Hybride	
	\\'Hybrid\\'	
	Unknown, data missing	NA
	unknown	
	Unknown	
	data missing	
	Inconnus, donnï¿½es manquantes	
	Sconosciuto	
Env_farmland	Yes	Yes
	Oui	
	Sì	

	\\'Yes\\'	
	\\'\\'\\'\\'Yes\\'\\'\\'\\'	
	No	No
	Non	
	Aucun	
	\\'No\\'	
		NA
Env_orchards	Yes	Yes
	Oui	
	Sì	
	\\'Yes\\'	
	No	No
	Non	
	Aucun	
	\\'No\\'	
	\\'\\'\\'\\'No\\'\\'\\'\\'	
		NA
Env_flora	Yes	Yes
	Oui	
	Sì	
	\\'Yes\\'	
	\\'\\'Yes\\'\\'	
	\\'\\'\\'\\'Yes\\'\\'\\'\\'	
	No	No
		NA
Env_town	Yes	Yes
	Oui	
	\\'Yes\\'	
	\\'\\'Yes\\'\\'	
	No	No
	Non	
	\\'\\'\\'\\'No\\'\\'\\'\\'	
		NA
Env_wood	Yes	Yes
	Oui	
	\\'Yes\\'	
	\\'\\'\\'\\'Yes\\'\\'\\'\\'	
	No	No
	Non	
	\\'No\\'	
		NA
Env_indus	Yes	Yes
	Oui	
	Sì	
	No	No
	Non	
	\\'No\\'	
	\\'\\'No\\'\\'	
	\\'\\'\\'\\'No\\'\\'\\'\\'	
		NA

HEALTH table

Variables	Categories stored in the database	New categories
Type_event	Chronic depopulation	Chronic depopulation
	Dépeuplement chronique	
	Clinical signs on broods	Clinical signs on broods

	Les signes cliniques sur les couvées	
	\\'\\'Clinical signs on broods\\'\\'	
	Clinical signs on honeybees	Clinical signs on honeybees
	Les signes cliniques sur les abeilles	
	High rate of colony mortality (>10%)	High rate of colony mortality
	High rate of colony mortality(>10%)	
	High rateof colony mortality(>10%)	
	Le taux élevé de mortalité des colonies (> 10%)	
	Le TAUX ELEVE de Mortalité des colonies (> 10%)	
	Taux élevé de mortalité des colonies (> 10%)	
	Mortalité des colonies haute rateof (> 10%)	
	\\'High rate of colony mortality(>10%)\\'	
	\\'\\'High rate of colony mortality(>10%)\\'\\'	
	high rate of honeybee mortality	High rate of honeybee mortality
	High rate of honeybee mortality	
	Le taux élevé de la mortalité des abeilles	
	Le TAUX ELEVE de la Mortalité des abeilles	
	Other	Other
	Autre	
	\\'Other\\'	
	Presence of varroa mites on adult honeybees	Presence of varroa mites on adult honeybees
	Présence de varroa sur les abeilles adultes	
	Présence de varroas sur les abeilles adultes	
	\\'Presence of varroa mites on adult honeybees\\'	
	\\'\\'\\'Presence of varroa mites on adult honeybees\\	
	Queen problems	Queen problems
	Queens problems	
	Problèmes Reine	
	Problèmes de la Reine	
	problèmes de la Reine	
	Unknown, data missing	NA
	Inconnu, données manquantes	

MANAGEMENT table

Variables	Categories stored in the database	New categories
Management	Increase the production	Production
	Augmenter la production	
	Increase the livestock and the production	
	Increase the livestock	Livestock
	Maintain the livestock	
	Maintain the livestock and Increase the livestock	
	Augmenter le bétail	
	Maintenir le bétail	
	MAINTENIR le Bétail	
	Maintenir le bï¿½tail	
	Aumentare il bestiame	
	Mantenere il bestiame	
	Improve the health condition	Health conditions
	To improve the health conditions	
	Unknown, data missing	NA
	Unknown	
	Inconnus, données manquantes	
	Inconnus, donnees manquantes	
	Inconnus, donnï¿½es manquantes	

MIGRATION table

Variables	Categories stored in the database	New categories

MidSeason_Target	Beans	Crops
	Colza	
	Lavander	
	Lavande	
	Lime	
	Orange	
	Orchards	
	Rapeseed	
	Raspberry	
	Sunflower	
	Acacia	Wildflowers
	Chestnut tree	
	Châtaigner	
	Castagno	
	Chestnut	
	Chestnut tree	
	Clover	
	Eucalyptus	
	Heather	
	Multiflower	
	Rosmarinus	
	Thymus	
	Other	Other
	Autre	
	Honeydew	
		NA

SYMPTOMS table

Variables	Categories stored in the database	New categories
Symptom	Black shiny honeybees	Black shiny honeybees rejected from the hive
	Black shiny honeybees rejected from the hive	
	Noir abeilles brillantes rejetés de la ruche	
	Brood and honey destruction	Brood and honey destruction
	Couvain et le miel destruction	
	destruction du couvain et de miel	
	La destruction du couvain et de miel	
	Cannibalism on larvae or on pupae	Cannibalism on larvae or on pupae
	Le cannibalisme des larves ou des pupes sur	
	Crawling honeybees, bees clinging to the grass	Crawling honeybees, bees clinging to the grass
	Crawling abeilles, abeilles s'accrochant à l'herbe	
	Crawling abeilles, abeilles s\\'accrochant à l\\'her	
	Dead colony	Dead colony
	Colonie morts	
	Dead honeybees back of the beehive	Dead honeybees in front of the hive
	Dead honeybees back of the beehive	
	Dead honeybees in front of the hive	
	Dead honeybees in front of th hive	
	Abeilles mortes devant la ruche	
	\\'\\'Dead honeybees in front of the hive\\'\\'	
	Dead honeybees within cells	Dead honeybees within cells
	Abeilles mortes dans les cellules	
	Les abeilles mortes devant la ruche	
	Doubtful clinical signs	Doubtful clinical signs
	Doubtful clinical signs (please specify on remark)	
	Doubtful clinical signs (please specify on ?remark	
	Doubtful clinical signs (please specify on ?remar	
	Doubtful clinical signs (please specify on ?remar	
	Doubtful clinical signs (please specify on ï¿½rema	
	Douteuses signes cliniques (s'il vous plaît précis	
	Signes cliniques douteuses (s'il vous plaît précis	
	Signes cliniques douteuses (s\\'il vous plaît préci	
	Signes douteuses Cliniques (s\\'il vous plaît préci	

	\\'Doubtful clinical signs (please specify on ?rema	
	Galleries inside the frames	Galleries inside the frames
	Galeries à l'intérieur des cadres	
	Honeybees with deformed and/or atrophied wings	Honeybees with deformed and/or atrophied wings
	honeybees with deformed and/or atrophied wings	
	Abeilles aux ailes déformées et / ou atrophiés	
	Les abeilles avec déformation et / ou ailes atroph	
	Les abeilles avec déformé et / ou des ailes atroph	
	\\'\\'Honeybees with deformed and/or atrophied wings	
	\\'Honeybees with deformed and/or atrophied wings\\'	
	Larvae with a yellowish to brown colour	Larvae with a yellowish to brown colour
	Les larves avec un jaunâtre au brun	
	Les Larves Avec Un jaunâtre au brun	
	Les larves d'une couleur jaunâtre à brun	
	Merged colony	Merged colony
	Sintomas nerviosos, desorientacion, con poco movimiento y nula agresividad	Nervous symptoms
	Sintomas nerviosos, desorientación, con poco movimiento y nula agresividad	
	Occupied flight board	Occupied flight board
	Impeded/Occupied flight board	
	Bord du vol occupé	
	Bord du vol Occupé	
	Les abeilles avec déformé et / ou des ailes atroph	
	\\'\\'Honeybees with deformed and/or atrophied wings	
	\\'Honeybees with deformed and/or atrophied wings\\'	
	Phoretic beetles, unusual larvae or eggs	Phoretic beetles, unusual larvae or eggs
	Phoretic varroa	Phoretic varroa
	Phorétique varroa	
	Phorétiques varroa	
	Varroa phorétiques	
	\\'Phoretic varroa\\'	
	Ropy larvae	Ropy larvae
	larves filant	
	Slumped larvae	Slumped larvae
	Sl umped larvae	
	Larves affalé	
	Specific odor of AFB	Specific odor of AFB
	Odeur spécifique de BAAR	
	Sold/given colony	Sold/given colony
	'Spotty' brood pattern	Spotty' brood pattern
	"Spotty" brood pattern	
	Pattern 'Spotty' couvain	
	Pattern 'Spotty' du couvain	
	Motif «tacheté» du couvain	
	\\'Spotty\\' brood pattern	
	Starvation	Starvation
	Suspect atypical mite	Suspect atypical mite
	Traces of diarrhea	Traces of diarrhea
	Des traces de diarrhée	
	Trembling honeybees	Trembling honeybees
	Abeilles tremblantes	

RESULTS table

Variables	Categories stored in the database	New categories
Analysis	American Foulbrood	American Foulbrood
	Loque américaine	
	European Foulbrood	European Foulbrood
	Loque européenne	
	Varroosis	Varroosis
	Varroasi	

	Varroose	
	Nosemosis Nosémose	Nosemosis
	Chronic Paralysis Paralysie chronique	Chronic Paralysis

C3 :New categories created to use EPILOBEE data

BEEKEEPER table

Variables	Conditions for each ID_api	Categories created for each ID_api
Bee_population_size	Number stored <=50	1 - 50 colonies
	Number stored > 50 AND Number stored <= 100	51 - 100 colonies
	Number stored > 100 AND Number stored <= 150	101 - 150 colonies
	Number stored > 150 AND Number stored <= 200	151 - 200 colonies
	Number stored > 200 AND Number stored <= 300	201 - 300 colonies
	Number stored > 300	More than 300 colonies
Apiary_size	Number stored <=5	1 - 5 colonies
	Number stored > 5 AND Number stored <= 10	6 - 10 colonies
	Number stored > 6 AND Number stored <= 20	11 - 20 colonies
	Number stored > 20 AND Number stored <= 50	21 - 50 colonies
	Number stored > 50	More than 50 colonies

HEALTH table

Variables	Conditions for each ID_api	Categories created for each ID_api[10]
Chronic_Depop	One of the events stored = { Chronic depopulation }	Yes
	Event stored = { }	No
	All the events stored ≠ { Chronic depopulation } AND ≠ { NA }	
	All the events stored ≠ { Chronic depopulation } with at least 1 NA stored	NA
ClinSign_Brood	One of the events stored = { Clinical signs on broods }	Yes
	Event stored = { }	No
	All the events stored ≠ { Clinical signs on broods } AND ≠ { NA }	
	All the events stored ≠ { Clinical signs on broods } with at least 1 NA stored	NA
ClinSign_Honeybees	One of the events stored = { Clinical signs on honeybees }	Yes
	Event stored = { }	No
	All the events stored ≠ { Clinical signs on honeybees } AND ≠ { NA }	
	All the events stored ≠ { Clinical signs on honeybees } with at least 1 NA stored	NA
H_Rate_ColMortality	One of the events stored = { High rate of colony mortality }	Yes
	Event stored = { }	No
	All the events stored ≠ { High rate of colony mortality } AND ≠ { NA }	
	All the events stored ≠ { High rate of colony mortality } with at least 1 NA stored	NA
H_Rate_HoneyMortality	One of the events stored = { High rate of honeybee mortality}	Yes
	Event stored = { }	No
	All the events stored ≠ { High rate of honeybee mortality } AND ≠ { NA }	
	All the events stored ≠ { High rate of honeybee mortality } with at least 1 NA stored	NA

[10] In the BEEKEEPER table

OtherEvent	One of the events stored = { Other }	Yes
	Event stored = { }	No
	All the events stored ≠ { Other } AND ≠ { NA }	
	All the events stored ≠ { Other } with at least 1 NA stored	NA
VarroaMites	One of the events stored = { Presence of varroa mites on adult honeybees}	Yes
	Event stored = { }	No
	All the events stored ≠ { Presence of varroa mites on adult honeybees } AND ≠ { NA }	
	All the events stored ≠ { Presence of varroa mites on adult honeybees } with at least 1 NA stored	NA
QueenProblems	One of the events stored = { Queen problems }	Yes
	Event stored = { }	No
	All the events stored ≠ { Queen problems } AND ≠ { NA }	
	All the events stored ≠ { Queen problems } with at least 1 NA stored	NA

MANAGEMENT table

Variables	**Conditions for each ID_api**	**Categories created for each ID_api**[11]
Management	Objective stored = { Production }	Production
	Objective stored = { Livestock }	Livestock
	Objective stored = { Health Conditions }	Health Conditions
	Objectives stored = { Production ; Livestock }	Prodcution + Livestock
	Objectives stored = { Production ; Health Conditions }	Production + Health Conditions
	Objectives stored = { Livestock ; Health Conditions }	Livestock + Health Conditions
	Objectives stored = { Production ; Livestock ; Health Conditions } { Production ; Livestock ; Health Conditions ; NA }	Prodcution + Livestock + Health Conditions
	Objective stored = { }	No Information
	Objectives stored = { NA } { Production ; NA } { Livestock ; NA } { Health Conditions ; NA } { Production ; Livestock ; NA } { Production ; Health Conditions; NA } { Livestock ; Health Conditions; NA }	NA
Swarm bought	Number stored = 0	None
	Number stored = 1	1 swarm bought
	Number stored > 1 AND Number stored <= 5	2 - 5 swarms bought
	Number stored > 5	More than 5 swarms bought
Swarm produced	Number stored = 0	None
	Number stored > 0 AND Number stored <= 5	1 - 5 swarm(s) produced
	Number stored > 5 AND Number stored <= 10	6 - 10 swarms produced
	Number stored > 10	More than 10 swarms produced
Queen_bought	Number stored = 0	None
	Number stored > 0 AND Number stored <= 5	1 - 5 queen(s) bought
	Number stored > 5 AND Number stored <= 10	6 - 10 queens bought
	Number stored > 10	More than 10 swarms bought

[11] In the BEEKEEPER table

Queen_produced	Number stored = 0	None
	Number stored > 0 AND Number stored <= 5	1 - 5 queen(s) produced
	Number stored > 5 AND Number stored <= 10	6 - 10 queens produced
	Number stored > 10	More than 10 swarms produced

MIGRATION table

Variables	**Conditions for each ID_api**	**Categories created for each ID_api**[12]
MidSeason_Target	Target stored = { Crops }	Crops
	Target stored = { Wildflowers }	Wildflowers
	Target stored = { Other }	Other
	Targets stored = { Crops ; Wildflowers } { Crops ; Others } { Wildflowers ; Others } { Crops ; Wildflowers ; NA } { Crops ; Others ; NA } { Wildflowers ; Others ; NA } { Crops ; Wildflowers ; Others } { Crops ; Wildflowers ; Others ; NA }	Diverse
	Target stored = { }	No Information
	Targets stored = { NA } { Crops ; NA } { Wildflowers ; NA } { Others ; NA }	NA

[12] In the BEEKEEPER table

VARIABLES TRANSFORMED

		Conditions for each ID_api						
	ID_api	*Env farmland* (BEEKEEPER table)	*Env orchards* (BEEKEEPER table)	*Env flora* (BEEKEEPER table)	*Env town* (BEEKEEPER table)	*Env wood* (BEEKEEPER table)	*Env indus* (BEEKEEPER table)	Categories created for each ID_api[13]
Environment	ID_01	Yes	No	No	No	No	No	Farmland
	ID_02	No	Yes	No	No	No	No	Orchards
	ID_03	No	No	Yes	No	No	No	Flora
	ID_04	No	No	No	Yes	No	No	Town
	ID_05	No	No	No	No	Yes	No	Wood
	ID_06	No	No	No	No	No	Yes	Industries
	ID_07	<---------- Two "Yes" reported anywhere ---------->						Diverse
	ID_08	<---------- Three "Yes" reported anywhere ---------->						
	ID_09	<---------- Four "Yes" reported anywhere ---------->						
	ID_10	<---------- Five "Yes" reported anywhere ---------->						
	…	Yes	Yes	Yes	Yes	Yes	Yes	
	….	No	No	No	No	No	No	None
	…	NA	NA	NA	NA	NA	NA	NA
	….	**One "Yes" reported**						
	…	Yes	NA	NA	NA	NA	NA	
	….	NA	Yes	NA	NA	NA	NA	
	…	NA	NA	Yes	NA	NA	NA	
	….	NA	NA	NA	Yes	NA	NA	
	…	NA	NA	NA	NA	Yes	NA	
	….	NA	NA	NA	NA	NA	Yes	
	…	**One "No" reported**						
	….	No	NA	NA	NA	NA	NA	NA
	…	NA	No	NA	NA	NA	NA	
	….	NA	NA	No	NA	NA	NA	
	…	NA	NA	NA	No	NA	NA	
	….	NA	NA	NA	NA	No	NA	
	…	NA	NA	NA	NA	NA	No	
	….	**Two "No" reported**						
	…	No	No	NA	NA	NA	NA	
	….	No	NA	No	NA	NA	NA	
	…	No	NA	NA	No	NA	NA	

[13] In the BEEKEEPER table

….	No	NA	NA	NA	No	NA
…	No	NA	NA	NA	NA	No
….	NA	No	No	NA	NA	NA
…	NA	No	NA	No	NA	NA
….	NA	No	NA	NA	No	NA
…	NA	No	NA	NA	NA	No
….	NA	NA	No	No	NA	NA
…	NA	NA	No	NA	No	NA
….	NA	NA	No	NA	NA	No
…	NA	NA	NA	No	No	NA
….	NA	NA	NA	No	NA	No
…	NA	NA	NA	NA	No	No
….	**Three "No" reported**					
…	No	No	No	NA	NA	NA
….	No	No	NA	No	NA	NA
…	No	No	NA	NA	No	NA
….	No	No	NA	NA	NA	No
…	No	No	NA	No	NA	NA
….	No	No	NA	NA	No	NA
…	No	No	NA	NA	NA	No
….	No	No	NA	NA	No	NA
…	No	No	NA	NA	NA	No
….	No	NA	No	No	NA	NA
…	No	NA	No	NA	No	NA
….	No	NA	No	NA	NA	No
…	No	NA	No	NA	No	NA
….	No	NA	No	NA	NA	No
…	No	NA	NA	No	No	NA
….	No	NA	NA	No	NA	No
…	No	NA	NA	NA	No	No
….	NA	No	No	No	NA	NA
…	NA	No	No	NA	No	NA
….	NA	No	No	NA	NA	No
…	NA	No	NA	No	No	NA
….	NA	No	NA	No	NA	No
…	NA	No	NA	NA	No	No
….	NA	NA	No	No	No	NA
…	NA	NA	No	No	NA	No
….	NA	NA	No	NA	No	No

	…	NA	NA	NA	No	No	No	
	….	**Four "No" reported**						
	…	No	No	No	No	NA	NA	
	….	No	No	No	NA	No	NA	
	…	No	No	No	NA	NA	No	
	….	No	No	NA	No	No	NA	
	…	No	No	NA	No	NA	No	
	….	No	No	NA	NA	No	No	
	…	No	NA	No	No	No	NA	
	….	No	NA	No	No	NA	No	
	…	No	NA	No	NA	No	No	
	….	No	NA	NA	No	No	No	
	…	NA	No	No	No	No	NA	
	….	NA	No	No	No	NA	No	
	…	NA	No	No	NA	No	No	
	….	NA	No	NA	No	No	No	
	…	NA	NA	No	No	No	No	
	….	**Five "No" reported**						
	…	No	No	No	No	No	NA	
	….	No	No	No	No	NA	No	
	…	No	No	No	NA	No	No	
	….	No	No	NA	No	No	No	
	…	No	NA	No	No	No	No	
	….	NA	No	No	No	No	No	

	Conditions for each ID_api				Categoriescreated for each ID_api[14]
	Analysis **(RESULTS table)**	***Result*** **(table RESULTS)**	***Detail*** **(RESULTS table)**	***Nature*** **(SAMPLE table)**	
American foulbrood	American Foulbrood	Positive OR Positif		Piece of brood (frame) OR Morceau de couvain (cadre) OR Pièce de couvain (cadre) OR Pezzo di covata (frame) OR \\'Piece of brood (frame)\\' OR Larvae, nymphs, scales OR Larves, nymphes, des Echelles OR Larves, nymphes, des échelles OR \\'Larvae, nymphs, scales\\' OR \\'Larves, nymphes, des échelles\\'	Suffering
		See details OR Voir les détails OR Vedi i dettagli OR \\'See details\\'	présence de spores de type paenibaccillus larvae OR présence de spores de type paenibacillus larvae OR présence spores type paenibaccillus larvae		
	Conditions reported above not met				Not Suffering

	Conditions for each ID_api				Categoriescreated for each ID_api[15]
	Analysis **(RESULTS table)**	***Result*** **(RESULTS table)**	***Detail*** **(RESULTS table)**	***Nature*** **(SAMPLE table)**	
European foulbrood	European Foulbrood	Positive OR Positif		Piece of brood (frame) OR Morceau de couvain (cadre) OR Pièce de couvain (cadre) OR Pezzo di covata (frame) OR \\'Piece of brood (frame)\\' OR Larvae, nymphs, scales OR Larves, nymphes, des Echelles OR Larves, nymphes, des échelles OR \\'Larvae, nymphs, scales\\' OR \\'Larves, nymphes, des échelles\\'	Suffering
	Conditions reported above not met				Not Suffering

[14] In the BEEKEEPER table

[15] In the BEEKEEPER table

	Conditions for each ID_api					Categories created for each ID_api[16]
	Country **(BEEKEEPER table)**	***Analysis*** **(RESULTS table)**	***Result*** **(RESULTS table)**	***Resaon*** **(SAMPLE table)**	***Suspected*** **(DISEASE table)**	
Varroosis (EPILOBEE first year)	BELGIUM OR ESTONIA OR FINLAND OR GERMANY OR HUNGARY OR ITALY OR LATVIA OR LITHUANIA OR POLAND OR SLOVAKIA OR SPAIN OR SWEDEN	Varroosis	Positive OR Positif	Symptomatic honeybees (20 per sample) OR Abeilles symptomatiques (20 par exemple) OR Symptomatic honeybees (20 per sample) OR \\'Symptomatic honeybees (20 per sample)\\' OR Symptomatic brood OR Couvée symptomatique OR \\'Symptomatic brood\\' OR \\'Couvée symptomatique\\' OR Suspect parasites OR parasites suspects		Suffering
	ENGLAND & WALES OR GREECE	Varroosis	Positive OR Positif	Symptomatic honeybees (20 per sample) OR Abeilles symptomatiques (20 par exemple) OR Symptomatic honeybees (20 per sample) OR \\'Symptomatic honeybees (20 per sample)\\' OR Symptomatic brood OR Couvée symptomatique OR \\'Symptomatic brood\\' OR \\'Couvée symptomatique\\' OR Suspect parasites OR parasites suspects OR Systematic honeybees (300 per sample)		
	DENMARK OR FRANCEE	Varroosis	Positive OR Positif	Symptomatic honeybees (20 per sample) OR Abeilles symptomatiques (20 par exemple) OR Symptomatic honeybees (20 per sample) OR \\'Symptomatic honeybees (20 per sample)\\' OR Symptomatic brood OR Couvée symptomatique OR \\'Symptomatic brood\\' OR \\'Couvée symptomatique\\'		

[16] In the BEEKEEPER table

				OR Suspect parasites OR parasites suspects		
					Varroosis OR Varroose OR \'Varroosis\'	
	Conditions reported above not met					Not Suffering

Varroosis (EPILOBEE second year)	**Conditions for each ID_api**					**Categoriescreated for each ID_api[17]**
	***Country* (BEEKEEPER table)**	***Analysis* (RESULTS table)**	***Result* (RESULTS table)**	***Resaon* (SAMPLE table)**	***Varroosis* (STRENGTH table)**	
	HUNGARY OR POLAND OR SPAIN OR SWEDEN	Varroosis	Positive OR Positif	Symptomatic honeybees (20 per sample) OR Abeilles symptomatiques (20 par exemple) OR Symptomatic honeybees (20 per sample) OR \\'Symptomatic honeybees (20 per sample)\\' OR Symptomatic brood OR Couvée symptomatique OR \\'Symptomatic brood\\' OR \\'Couvée symptomatique\\' OR Suspect parasites OR parasites suspects		Suffering
	BELGIUM OR ESTONIA OR FINLAND OR FRANCEE OR GERMANY OR GREECE OT ITALY OR LATVIA OR LITHUANIA OR SLOVAKIA	Varroosis	Positive OR Positif	Symptomatic honeybees (20 per sample) OR Abeilles symptomatiques (20 par exemple) OR Symptomatic honeybees (20 per sample) OR \\'Symptomatic honeybees (20 per sample)\\' OR Symptomatic brood OR Couvée symptomatique OR \\'Symptomatic brood\\' OR \\'Couvée symptomatique\\' OR Suspect parasites OR parasites suspects		
					Yes	
	DENMARK	Conditions similar to the conditions applied at EPILOBEE first year				
	Conditions reported above not met					Not Suffering

[17] In the BEEKEEPER table

	Conditions for each ID_api				Categoriescreated for each ID_api[18]
	Analysis **(RESULT table)**	***Result*** **(RESULTS table)**	***Detail*** **(RESULTS table)**	***Nature*** **(SAMPLE table)**	
Nosemosis	Nosemosis	Positive OR Positif		Living external honeybees OR Dead honeybees OR Abeilles mortes	Suffering
		See details OR Voir les détails OR Vedi i dettagli OR \\'See details\\'	POSITIF NIVEAU 1 OR POSITIF NIVEAU 2 OR POSITIF NIVEAU 3 OR POSITIF NIVEAU 4 OR POSITIF NIVEAU1 OR POSITIFNIVEAU 1		
	Conditions reported above not met				Not Suffering

	Conditions for each ID_api				Categoriescreated for each ID_api[19]
	Analysis **(RESULTS table)**	***Result*** **(RESULTS table)**	***Detail*** **(RESULTS table)**	***Nature*** **(SAMPLE table)**	
Chronic paralysis	Chronic Paralysis	Positive OR Positif		Living external honeybees OR Dead honeybees OR Abeilles mortes	Suffering
	Conditions reported above not met				Not Suffering

	Conditions for each ID_api	Categoriescreated for each ID_api[20]
Migration	The ID_api from the BEEKEEPER table matched with an ID_api from the MIGRATION table	Yes
	The ID_api from the BEEKEEPER table did not match with any ID_api from the MIGRATION table	No

[18] In the BEEKEEPER table
[19] In the BEEKEEPER table
[20] In the BEEKEEPER table

	Conditions for each ID_api		Categoriescreated for each ID_api[21]
	merged_v1_v2 **(VISIT table)**	***merged_v2_v3*** **(VISIT table)**	
Merger	Number stored = 0	Number stored ≠ 0	Yes
	Number stored ≠ 0	Number stored = 0	
	Number stored ≠ 0	Number stored ≠ 0	
	Number stored = 0	Number stored = 0	No
	Number stored = NA	Number stored = NA	NA

	Conditions for each ID_api	Categoriescreated for each ID_api[22]
Winter mortality class	winter mortality calculated = 0	No mortality
	winter mortality calculated > 0 AND winter mortality calculated <= 5	1 - 5 %
	winter mortality calculated > 5 AND winter mortality calculated <= 10	6 - 10 %
	winter mortality calculated > 10 AND winter mortality calculated <= 20	11 - 20 %
	winter mortality calculated > 20 AND winter mortality calculated <= 50	21 - 50 %
	winter mortality calculated > 50	More than 50 %

	Conditions for each ID_api	Categoriescreated for each ID_api[23]
First_Second	The ID_api of the dataset from EPILOBEE first year matched with an ID_api of the dataset from EPILOBEE second year	Yes
	The ID_api of the dataset from EPILOBEE first year did not match with any ID_api of the dataset from PILOBEE second year	No

[21] In the BEEKEEPER table
[22] In the BEEKEEPER table
[23] In the BEEKEEPER table

Appendix D – Data checks and edits

Check steps

The checks were applied to two tables: VISIT and BEEKEEPER_APIARY. The first eight checks refered to the VISIT table. The last four checks refered to the BEEKEEPER_APIARY table.

Check #1: data completeness

The *Random* variable recorded the number of colonies randomly selected during the autumn visit. Sometimes, for several reasons (e.g. information not collected, information lost), this information was not reported, and the database returned NA. Without this information, the mortality could not be calculated.

The check consisted in:

$$Random \neq NA$$

The apiaries with *Random* = NA were removed.

Check #2: consistency check

During the spring visit, the *Random_v1_rap* variable recalled the Random entry at v1 (Autumn). Sometimes, the information returned by these two entries were different. For these records, the real information was missing.

The check consisted in:

$$Random = Random\_v1\_rap$$

The apiaries with *Random* ≠ *Random_v1_rap* were removed.

Check #3: data completeness

The *Alive_v2* variable recorded the number of colonies alive at the spring visits. Sometimes, this information was not reported and the database returned NA.

The check consisted in:

$$Alive\_v2 \neq NA$$

The apiaries with *Alive_v2* = NA were removed.

Check #4: data completeness

The *Alive_v3* variable recorded the number of colonies alive during the summer visits. Sometimes, this information was not reported and the database returned NA.

The check consisted in:

$$Alive\_v3 \neq \text{NA}$$

The apiaries with *Alive_v3*= NA were removed.

Check #5: data completeness

The *Dead_v1_v2* variable recorded the number of dead colonies between the autumn and the spring visits. Sometimes, this information was not reported.

The check consisted in:

$$Dead\_v1\_v2 \neq \text{NA}$$

The apiaries with *Dead_v1_v2* = NA were removed.

Check #6: data completeness

The *Dead_v2_v3* variable recorded the number of dead colonies between the spring and the summer visits. Sometimes, this information was not reported.

The check consisted in:

$$Dead\_v2\_v3 \neq \text{NA}$$

The apiaries with *Dead_v2_v3* = NA were removed.

Check #7: consistency check

During the spring visit, the number of colonies (alive, dead and sold by the beekeeper between the autumn and the spring) had to be equal to the number of colonies randomly selected at the autumn visit (*Random*). For some records, this equality was not respected.

The check consisted in:

$$Random = Alive\_v2 + Dead\_v1\_v2 + sold\_v1\_v2$$

The apiaries with $Random \neq Alive\_v2 + Dead\_v1\_v2 + sold\_v1\_v2$ were removed.

Check #8: consistency check

During the summer visit, the number of colonies (alive, dead and sold by the beekeeper between the spring and the summer visits) had to be equal to the number of colonies still alive at the spring visit. For some records, this equality was not respected.

The check consisted in:

$$Alive\_v2 = Alive\_v3 + Dead\_v2\_v3 + sold\_v2\_v3$$

The apiaries with $Alive\_v2 \neq Alive\_v3 + Dead\_v2\_v3 + sold\_v2\_v3$ were removed.

Check #9: data completeness

The *Apiary_size* variable recorded the number of colonies present in the selected apiary. For some records, the number entered into this variable was equal to 0.

The check consisted in:

$$Apiary\_size \neq 0$$

The apiaries with $Apiary\_size = 0$ were removed.

Check #10: consistency check

This check referred to the BEEKEEPER_APIARY table and the VISIT table.

For a given selected apiary, the number of colonies randomly selected (*Random*) should have be inferior or equal to the number of colonies present in this apiary (*Apiary_size*). For some records, this condition was not respected.

The check consisted in:

$$Random \leq Apiary\_size$$

The apiaries with $Random > Apiary\_size$ were removed.

Check #11: consistency check

The number of apiaries owned by a given beekeeper was recorded under the *Apiaries* variable. The total number of colonies belonging to a given beekeeper (taking into account all his/her apiaries) was recorded under the *Bee_population_size* variable. If a beekeeper owned only one apiary (*Apiaries*=1), the total number of colonies belonging to the beekeeper (*Bee_population_size* variable) had to be

equal to the number of colonies present in this apiary (*Apiary_size*). For some records, this condition was not respected.

The check consisted in:

If *Apiaries* = 1, *Bee_population_size* = *Apiary_size*

The apiaries with *Apiaries* = 1 and *Bee_population_size* ≠ *Apiary_size* were removed.

Specific case

For some MS, the condition "If *Apiaries* = 1, *Bee_population_size* = *Apiary_size*" was not respected because of nomadic beekeeping.
In this case, all the colonies owned by a beekeeper were not located in the same place. It was considered that the beekeeper owned a unique apiary registered in one place, the colonies being not necessarily located at this address. In EPILOBEE, for a selected apiary, the number of colonies present in the apiary (*Apiary_size* variable) corresponded to the number of colonies found at the location of the apiary during the first visit. The total number of colonies belonging to this apiary (including the remote colonies) corresponded to the total number of colonies belonging to the beekeeper (*Bee_population_size* variable).
For example, a beekeeper could own one apiary (*Apiaries* = 1) with 258 colonies (*Bee_population_size* = 258) and only 20 colonies were found at the address of the apiary (*Apiary_size* = 20).

The condition "If *Apiaries* = 1, *Bee_population_size* = *Apiary_size*" did not apply in the case.
During EPILOBEE first year, Greece and England and Wales had some nomadic beekeeping practices; during EPLOBEE second year, Greece, Estonia, Hungary and an area in France did.

Check #12: consistency check

If a beekeeper owned more than one apiary (*Apiaries* > 1), the total number of colonies belonging to the beekeeper (*Bee_population_size*) had to be higher than the number of colonies present in the apiary selected (*Apiary_size*). For some records, this condition was not respected.

The check consisted in:

If *Apiaries* > 1, *Bee_population_size* > *Apiary_size*

The apiaries with *Apiaries* > 1 and *Bee_population_size* ≤ *Apiary_Size* were removed.

Specific case

For Hungary and France, the condition "If *Apiaries* > 1, *Bee_population_size* > *During_visit*" did not apply. Indeed for the beekeepers participating in the project during the two years of EPILOBEE , the data entered under the *Apiaries* and *Bee_population_size* variables for EPILOBEE first year were unfortunalely not updated for EPILOBEE second year. However, this was not the case for the data entered under the *During_visit* variables (for the *Apiary_size* variable during EPILOBEE first year; see special edit B).
Example: at the beginning of EPILOBEE first year, a beekeeper owned 3 apiaries (*Apiaries* = 3) with 20 colonies in total (*Bee_population_size* = 20) and 10 colonies present in the selected apiary (*Apiary_size* = 10). At the beginning of EPILOBEE second year, the beekeeper got a fourth apiary with 25 colonies. Therefore the total number of colonies was equal to 45. This new apiary was selected for EPILOBEE second year: the number of colonies in the selected apiary was 25 (*During_visit* = 25). However, the data entered in the *Apiaries* and *Bee_population_size* variables were unfortunalely not updated. Thus, *Apiaries* = 3, *Bee_population_size* = 20 and *During_visit* = 25. Therefore the condition was no longer respected.
Since the data entered under the *During_visit* variable was correct, it was kept for the analysis

Special check #A

Portugal did not correctly implement the protocol regarding the sampling of colonies. Consequently, the disease prevalence could not be calculated and compared to the results from the other MS. Given that this risk factor was included in the statistical analysis, Portuguese data were removed. The data from Portugal were kept in the analysis only to study the effect of the *Country* variable.

Special check #B

The *Apiary_size* variable recording the number of colonies present in a selected apiary was moved to the VISIT table for the second year of EPILOBEE (variable named *During_visit*).This allowed to have information on the apiary size at each visit.

Thus, for the data of EPILOBEE second year, the checks related to the variable *Apiary_size* (9th to 12th) were applied to the *During_visit* variable.

The main objective of this special check was to obain valid data from *During_visit* (i.e. different from NA). Therefore the apiaries with *During_visit* = NA were removed.

Editing steps

Edit #1:

For a given apiary, during the spring visit, if there was no information on the number of sold colonies between the autumn and spring visits (*sold_v1_v2*=NA), it was assumed that no colony was sold between the autumn and spring visits (*sold_v1_v2*=0).

If *sold_v1_v2* = NA, *sold_v1_v2* = 0

Edit #2:

For a given apiary, during the summer visit, if there was no information on the number of sold colonies between the spring and summer visits (*sold_v2_v3*=NA), it was assumed that no colony was sold between the spring and summer visits (*sold_v2_v3*=0).

If *sold_v2_v3* = NA, *sold_v2_v3* = 0

These two edit steps were applied in order to keep as much data as possible in the analysis (see the text, Table 4)

Edit #3:

For a given apiary,

- if the number of colonies randomly selected at the autumn visit was equal to the number of colonies alive at the spring visit (*Random* = *Alive_v2*), and
- if no colonies were sold between the autumn and spring visits (*sold_v1_v2* = 0), and
- if there was no information on the number of dead colonies between the autumn and spring visits (*dead_v1_v2*=NA),

we assumed that no colony died between the autumn and spring visits (*dead_v1_v2*=0).

If *Random* = *Alive_v2*

If *sold_v1_v2* = *0* and *dead_v1_v2* = NA

→ *Dead_v1_v2* = 0

Edit #4:

For a given apiary,

- if the number of colonies alive at the spring visit was equal to the number of colonies alive at the summer visit (*Alive_v2* = *Alive_v3*), and
- if no colonies were sold between the spring and summer visits (*sold_v2_v3* = 0), and
- if there was no information on the number of dead colonies between the spring and summer visits (*dead_v2_v3*=NA),

we assumed that no colony died between the spring and the summer visits (*dead_v2_v3*=0).

If *Alive_v2* = *Alive_v3*

If *sold_v2_v3* = *0* and *dead_v2_v3* = NA

→ *Dead_v2_v3* = 0

Edit #3 and Edit #4:

These two edits did not apply to the Finnish data during EPILOBEE second year as Finland confirmed that the NA values reported in the *dead_v1_v2* and *dead_v2_v3* variables from the VISIT table meant 0.

Appendix E – Selection of the explanory variables to be included in the statistical analysis

E1: Criterion #1: Expert opinion

Four experts, in honeybee pathology, epidemiology and honeybee field work ranked all the variables depending on the significance of each variable for explaining the honeybee colony mortality: 1 = variable with a high significance; 2= variable with moderate significance; 3 = variable without any significance. A total score was built by the sum of all expert rankings (from 4 - all the experts agreed on the importance of the variable, up to 12 - all the experts agreed that the variable was without any importance).

A colour coding was applied to the tables summing up the ranks: green when the lowest sum was achieved (all the experts agreed on the importance of the variable); yellow when the sum was between 5 and 7 (variable with moderate interest); blue when the sum was between 8 and 11 (variable with low interest) and red when the highest score was reached (12, meaning that all the experts agreed on the null interest of the variable).

- Sum = 4
- Sum between 5 and 7
- Sum between 8 and 11
- Sum = 12

Variables mainly voted with high or moderate importance (total score of 4 to 7) were kept for the statistical analysis. Variables in blue and red were not included in the statistical analysis. However excluded variables could be re-included in the analysis when applying the other three criteria.

BEEKEEPER table

	expert 1	expert 2	expert 3	expert 4	TOTAL
ID_api	1	1	1	1	**4**
Surname	1	2	3	2	**8**
Name	1	2	3	1	**7**
Postal_adress	3	3	3	3	**12**
Zipcode	1	1	3	1	**6**
City	1	3	3	2	**9**
Tel	3	3	3	3	**12**
Fax	3	3	3	3	**12**
E.mail	3	3	3	3	**12**
Identification	1	1	3	1	**6**
Age	2	2	2	1	**7**
Activit	1	2	1	1	**5**
Beekeep_for	2	2	2	1	**7**
Org_member	2	2	3	1	**8**
Qualif	2	2	2	1	**7**
Training	2	2	2	1	**7**
Continue	3	3		3	**9**
Follower	3	3		3	**9**
Coop_treat	2	2		1	**5**
Apiaries	1	2	1	1	**5**
Bee_population_size	1	2	1	1	**5**
Country	2	1	1	1	**5**
Nuts1_apiary	2	2	1	1	**6**
Nuts2_apiary	2	3	1	2	**8**
Nuts3_apiary	2	3	1	2	**8**
LAU	2	3	1	2	**8**
Lat	2	2	1	3	**8**
Long	2	2	1	3	**8**
Migration	1	2	1	1	**5**
Apiary_size	1	1	1	1	**4**
Breed	1	2	3	3	**9**
Production	1	2	3	1	**7**
Env_farmland	1	3	1	2	**7**
Type_farmland	1	3	1	2	**7**
Env_orchards	1	3	1	2	**7**
Specie_orchards	1	3	1	2	**7**
Env_flora	1	3	1	2	**7**
Env_wood	1	3	1	2	**7**
Env_town	1	3	1	2	**7**
Env_indus	1	3	1	2	**7**
Env_other	1	3	1	2	**7**
Apiarist_book	1	2	3	1	**7**
Queen_import	1	2	3	1	**7**
Queen_import_or	1	2	3	1	**7**
Queen_import_or2	1	2	3	1	**7**
Harbor	1	2	1	1	**5**
Airport	1	2	1	1	**5**
Other_risk	1	3	3	2	**9**

COLONY table

Please note that the *Strength_colonie* variable was removed from this table during EPILOBEE second year to be part of the new table STRENGTH added to the database during the second year of EPILOBEE.

	expert 1	expert 2	expert 3	expert 4	TOTAL
ID_api	1	1	1	1	**4**
ID_colony	1	1	1	1	**4**
Field_ID	2	1	1	1	**5**
Reason	1	1	1	1	**4**
~~Strength_colonie~~	1	1	1	1	**4**

DISEASE table

	expert 1	expert 2	expert 3	expert 4	TOTAL
ID_colony	3	1	1	1	**6**
ID_suspicion	3	1	1	1	**6**
Suspected	3	1	1	1	**6**
Remark	3	1	3	1	**8**
Date	3	1	1	1	**6**

HEALTH table

	expert 1	expert 2	expert 3	expert 4	TOTAL
ID_api	3	2	1	1	**7**
ID_event	3	2	1	1	**7**
Type_event	3	2	2	1	**8**
Other	3	2	2	2	**9**
Disease_event	3	2	2	1	**8**
Other_D	3	2	2	2	**9**
Percent_affected	3	2	2	1	**8**
Lab	3	2	2	1	**8**
Conclusion	3	2	2	1	**8**
Other_C	3	2	2	1	**8**
Treatment	3	2	2	1	**8**

MANAGEMENT table

	expert 1	expert 2	expert 3	expert 4	TOTAL
ID_api	1	2	1	1	**5**
ID_management	1	2	1	1	**5**
Management	1	2	3	1	**7**
Swarm_bought	1	2	3	1	**7**
Swarm_or	1	3	3	1	**8**
Swarm_produced	1	2	3	1	**7**
Queen_bought	1	2	3	1	**7**
Queen_or	1	3	3	1	**8**
Queen_produced	1	2	3	1	**7**
Date_action	1	2	3	1	**7**
Colonie_divided	1	2	3	1	**7**
Colonie_naturally	1	2	3	1	**7**
Colonie_merged	1	2	3	1	**7**

MIGRATION table

	expert 1	expert 2	expert 3	expert 4	TOTAL
ID_api	1	2		1	**4**
ID_migr	1	2		1	**4**
Start	3	2	2	1	**8**
End	3	2	2	1	**8**
Place2	3	2	2	3	**10**
Place3	3	3	2	3	**11**
MidSeason_Target	3	3	2	3	**11**
Other	3	3	2	3	**11**
colonie	3	2	2	3	**10**

RESULT table

	expert 1	expert 2	expert 3	expert 4	TOTAL
ID_sample	1	1		1	**3**
ID_result	1	1		1	**3**
Apiary	1	3		1	**5**
Lab_ID	1	1		1	**3**
Analysis	1	1	1	1	**4**
Technique	1	1	3	1	**6**
Result	1	1	1	1	**4**
Detail	1	1	1	2	**5**
Comment	2	1	3	2	**8**
Date	2	2	1	1	**6**
Number_varroa	1	1	1	1	**4**
Number_nosema	1	1	1	1	**4**

SAMPLE table

	expert 1	expert 2	expert 3	expert 4	TOTAL
ID_colony	1	1		1	**3**
ID_sample	1	1		1	**3**
Reason	1	1	1	1	**4**
Nature	1	1	1	1	**4**
DateV	1	1	1	1	**4**
Field_ID	2	1		1	**4**

STRENGTH table

The expert opinion was not applied to the STRENGTH table as this table was added during the second year of the program. Consequently, only data from EPILOBEE second year were recorded in this table.

SYMPTOM table

	expert 1	expert 2	expert 3	expert 4	TOTAL
ID_colony	2	1		1	**4**
ID_symptom	2	1		1	**4**
Symptom	2	1	3	1	**7**
Remark	2	1	3	2	**8**
Date	2	1	3	1	**7**

TREATMENT table

	expert 1	expert 2	expert 3	expert 4	TOTAL
ID_api	1	2		1	**4**
ID_treatment	1	2		1	**4**
Date_treat	2	2	1	1	**6**
Name_treat	1	2	1	1	**5**
Ingredient	1	3	3	1	**8**
Posology	2	3	3	1	**9**
Duration	2	2	3	1	**8**
Remark	2	3	3	2	**10**
Frequence	2	2	1	1	**6**
Treatment_correctly	1	3	1	1	**6**

VISIT table

Please note that the *Strength_colonie* variable was removed from this table during EPILOBEE second year to be part of the new table STRENGTH added to the database during the second year of EPILOBEE.

	expert 1	expert 2	expert 3	expert 4	TOTAL
ID_api	1	1		1	**3**
ID_visit	1	1		1	**3**
Date	2	1		1	**4**
Rank	1	1	1	1	**4**
Inspected	1	3	1	1	**6**
Visitor1	3	1	3	3	**10**
Visitor2	3	2	3	3	**11**
Km	3	3	3	2	**11**
Time	3	3	3	2	**11**
Random	1	2	1	1	**5**
Random_v1_rap	1	1	1	1	**4**
Alive_v2	1	1	1	1	**4**
Dead_v1_v2	1	1	1	1	**4**
Merged_v1_v2	1	1	1	1	**4**
sold_v1_v2	1	1	1	1	**4**
Divided_v1_v2	1	1	1	1	**4**
Alive_v3	1	1	1	1	**4**
Dead_v2_v3	1	1	1	1	**4**
Merged_v2_v3	1	1	1	1	**4**
sold_v2_v3	1	1	1	1	**4**
Divided_v2_v3	1	1	1	1	**4**
Previous_visit	1	2	1	1	**5**
Moving_apiary	1	2	1	1	**5**
During_visit	1	1	1	1	**4**
Visited_apiary	1	2	1	1	**5**
Farm_general	1	2	1	1	**5**
Produce_v1_v2	1	2	1	1	**5**
Produce_v2_v3	1	2	1	1	**5**
~~Strength_colonie~~	1	3	1	1	**6**

E2: Criterion #2: Data completeness

This criterion gave for each table the percentage of data completeness for each variable. The results were reported in colored tables. The percentage of data completeness was calculated as follow:

$$\text{percentage of data completenees (varaible V)} = \frac{\text{number of records without any NA}}{\text{total number of records}}$$

Variables with a high percentage of data completeness were placed at the top of the table and variables with the lowest percentage at the bottom of the table.This criterion uses the results of criterion #1:

- all the variables in the green and yellow categories (from criterion #1) were located on the left side of the page. These variables were included in the analysis
- all the variables in blue and red (from criterion #1) were located on the right side of the page. These variable were not included in the analysis based on the results of criterion #1. However, further examination of the variables might include some of these variables.

BEEKEEPER table

Variables	Number of records	Number of records with consitent data	Percentage
Identification	5572	5572	100,00%
Apiaries	5572	5572	100,00%
Bee_population_size	5572	5572	100,00%
Country	5572	5572	100,00%
Harbor	5572	5572	100,00%
Airport	5572	5572	100,00%
Nuts1_apiary	5572	5567	99,91%
Nuts2_apiary	5572	5567	99,91%
Nuts3_apiary	5572	5567	99,91%
ZipCode	5572	5423	97,33%
Name	5572	5422	97,31%
Activity	5572	5401	96,93%
Migration	5572	5257	94,35%
Queen_import	5572	5062	90,85%
Production	5572	5033	90,33%
Age	5572	4704	84,42%
Beekeep_for	5572	4658	83,60%
Apiary_Size	5572	4519	81,10%
Env_flora	5572	4470	80,22%
Qualif	5572	4405	79,06%
Env_wood	5572	4387	78,73%
Coop_treat	5572	4288	76,96%
Training	5572	4094	73,47%
Env_orchards	5572	4093	73,46%
Apiarist_book	5572	3980	71,43%
Env_town	5572	3857	69,22%
Env_farmland	5572	3841	68,93%
Env_indus	5572	3696	66,33%
Env_other	5572	741	13,30%

BEEKEEPER table

Variables	Number of records	Number of records with consitent data	Percentage
Postal adress	5572	57423	97,3
City	5572	5423	97,3
Surname	5572	5057	90,7
Breed	5572	5053	90,6
Follower	5572	4999	89,7
Lat	5572	4914	88,1
Long	5572	4914	88,1
Org_member	5572	4716	84,6
Continue	5572	4570	82,0
LAU	5572	4090	73,4
Tel	5572	2857	51,2
E-mail	5572	1203	21,5
Other risk	5572	425	7,6
Fax	5572	69	1,2

BEEKEEPER table
Env_farmaland=Yes

Variables	Number of records	Number of records with consitent data	Percentage
Type_farmland	3475	2068	59,51%

BEEKEEPER table
Env_orchards=Yes

Variables	Number of records	Number of records with consitent data	Percentage
Specie_orchards	2003	1139	56,86%

BEEKEEPER table
Queen_import=Yes

Variables	Number of records	Number of records with consitent data	Percentage
Queen_import_or	29	9	31,03%

Variables	Number of records	Number of records with consitent data	Percentage
Queen_import_or_2	1	1	100,00%

COLONY table

Variables	Number of records	Number of records with consitent data	Percentage
Field_ID	60 581	60 581	100,00%
Reason	60 581	60 581	100,00%
Strength_colonie	60 581	22 826	37,68%

COLONY table

There was no variable classified in blue or red (from the criterion #1) in the COLONY

DISEASE table

Variables	Number of records	Number of records with consitent data	Percentage
Suspected	37 189	37 189	100,00%
Date	37 189	37 189	100,00%

DISEASE table

Variables	Number of records	Number of records with consitent data	Per
Remark	37 189	20 68	5

HEALTH table

There was no variable classified in green or yellow (from the tool #1) in the HEALTH table.

HEALTH table

Variables	Number of records	Number of records with consitent data	Per
Type_event	5 693	5 418	9
Percentage affected	5 693	5 144	9
Disease_event	5 693	3 130	5
Lab	5 693	1 984	3
Other_D	5 693	1 579	2
Treatment	5 693	1 307	2
Conclusion	5 693	891	1
Other	5 693	726	1
Other_C	5 693	114	2

MANAGEMENT table

Variables	Number of records	Number of records with consitent data	Percentage
Queen_bought	15 508	15 397	99,28%
Swarm_bought	15 508	15 396	99,28%
Swarm_produced	15 508	15 394	99,26%
Queen_produced	15 508	15 392	99,26%
Management	15 508	14 462	93,26%
Date_action	15 508	12 622	81,39%
Colonie_merged	15 508	9 428	60,79%
Colonie_divided	15 508	9 427	60,79%
Colonie_naturally	15 508	9 426	60,78%

MANAGEMENT table

Variables	Number of records	Number of records with consitent data	Per
Queen_or	15 508	2 513	1
Swarm_or	15 508	819	5

MIGRATION table

There was no variable classified in green or yellow (from thecriterion #1) in the MIGRATION table.

MIGRATION table

Variables	Number of records	Number of records with consitent data	Per
Start	3082	3 062	9
MidSeason_Target	3082	3 043	9
End	3082	3 038	9
Place2	3082	2 241	7
Place3	3082	2 123	6
Other	3082	1 658	5
Colonie	3082	772	2

RESULTS table

Variables	Number of records	Number of records with consitent data	Percentage
Analysis	166 621	166 619	99,99%
Date	166 621	166 640	99,88%
Result	166 621	153 188	91,94%
Technique	166 621	142 027	85,26%
Lab_ID	166 621	131 065	78,66%
Apiary	166 621	15 355	9,22%

RESULTS table
Analysis = Varroa counting

Variables	Number of records	Number of records with consitent data	Percentage
Number_varroa	63 507	56 882	89,57%

RESULTS table
Analysis = Nosemosis

Variables	Number of records	Number of records with consitent data	Percentage
Number_nosema	13 105	4 403	33,60%

RESULTS table

Variables	Number of records	Number of records with consitent data	Per
Comment	166 621	19 259	1

SAMPLE table

Variables	Number of records	Number of records with consitent data	Percentage
Reason	87 085	87 085	100,00%
Nature	87 085	87 085	100,00%
DateV	87 085	87 085	100,00%
Fiel_ID	87 085	87 085	100,00%

SAMPLE table

There was no variable classified in blue or red (from the criterion #1) in the SAMPLI

STRENGTH table

Variables	Number of records	Number of records with consitent data	Percentage
Dead	72 975	72 975	100,00%
Force	72 975	72 975	100,00%
Date	72 975	72 975	100,00%
Fiel_ID	72 975	72 975	100,00%
Future	72975	72 975	100,00%
Type	72975	72 975	100,00%
Varroosis	72975	72 975	100,00%

STRENGTH table

There was no variable classified in blue or red (from the criterion #1) in the STREN

SYMPTOMS table

Variables	Number of records	Number of records with consitent data	Percentage
Symptom	48 593	48 593	100,00%
Date	48 593	48 593	100,00%

SYMPTOMS table

Variables	Number of records	Number of records with consitent data	P
Remark	48 593	19 041	

TREATMENT table

Variables	Number of records	Number of records with consitent data	Percentage
Date_treat	18 582	18 566	99,91%
Name_treat	18 582	14 946	80,43%
Frequence	18 582	7 769	41,81%
Treatment_correctly	18 582	2 343	12,61%

TREATMENT table

Variables	Number of records	Number of records with consitent data	Pe
Ingredient	18 582	18 305	9
Posology	18 582	12 291	6
Duration	18 582	11 795	6
Remark	18 582	5 758	3

VISIT table
Autumn

Variables	Number of records	Number of records with consitent data	Percentage
Random	6 218	6 200	99,71%

VISIT table
Spring

Variables	Number of records	Number of records with consitent data	Percentage
Alive_v2	6 119	6 083	99,41%
Dead_v1_v2	6 119	5 948	97,21%
Merged_v1_v2	6 119	5 828	95,24%
sold_v1_v2	6 119	5 826	95,21%
Divided_v1_v2	6 119	3 598	58,80%
Produce_v1_v2	6 119	2 789	45,58%

VISIT table
Summer

Variables	Number of records	Number of records with consitent data	Percentage
Alive_v3	5 893	5 870	99,61%
Dead_v2_v3	5 893	5 696	99,66%
sold_v2_v3	5 893	5 664	96,11%
Merged_v2_v3	5 893	5 660	96,05%
Divided_v2_v3	5 893	3 092	52,47%
Produce_v2_v3	5 893	2 739	46,48%

VISIT table
Spring+Summer

Variables	Number of records	Number of records with consitent data	Percentage
Random_v1_rap	12 012	11 919	99,23%

VISIT table
3 visits

Variables	Number of records	Number of records with consitent data	Percentage
Rank	18 231	18 231	100,00%
Date	18 231	18 231	100,00%
Inspected	18 231	10 238	56,16%
During_visit	18 231	8 286	45,45%
Previous_visit	18 321	7 323	40,17%
Visited_apiary	18 231	4 020	22,05%
Farm_general	18 231	4 005	21,97%
Moving_apiary	18 231	483	2,65%

VISIT table
3 visits

Variables	Number of records	Number of records with consitent data	
Visitor1	18 231	18 037	
Km	18 231	17 903	
Time	18 231	17 584	
Visitor2	18 231	4 440	

E3: Criterion #3: Data relevance

This criterion looked at the format of the 138 variables:

- if the variable was a categorical variable, the number and the detail of categories was reported
- if the variable was a continuous variable, the minimum and the maximum were indicated
- if the variable was a date, the oldest and the more recent dates were indicated
- if data were stored in free fields, the variable was not included in the analysis due to the difficulties with the usage of the information

When there was a high number of categories (more than 30 for example), only the number of categories were reported to avoid sorting and grouping the categories. This process is difficult, time consuming and possibly irrelevant in such cases.

Similarly to the criterion #2, the results are presented in two categories: first the variables in the green and yellow categories (resulting from criterion #1); second the variables in the blue and red categories (resulting from criterion #1).

BE = data from the Belgian file for EPILOBEE first year
SP = data from the Spanish file for the two years of EPILOBEE
EU = data from the EPILOBEE database for the two years of EPILOBEE

BEEKEEPER table (green and yellow categories from the criterion #1).

Name	2160 different categories (EU) / 154 different categories (SP)
ZipCode	3456 different categories (EU) / 154 different categories (SP)
Identification	4533 different categories (EU) / 394 different categories (SP) / 149 different categories (BE)
Age	Less than 30
	30-45
	45-65
	Over 65
Activity	Hobby
	Part-time
	Professional
Beekeep_for	less than 2 years
	2-5 years
	more than 5 years
Qualif	Yes
	No
Training	Yes
	No
Coop_treat	Yes
	No
Apiaries	Number from 0 to 500
Bee_population _size	Number from 0 to 4500
Country	BELGIUM
	DENMARK
	ESTONIA
	FINLAND
	FRANCE
	GERMANY
	GREECE
	HUNGARY
	ITALY
	LATVIA
	LITHUANIA

	POLAND	
	PORTUGAL	
	SLOVAKIA	
	SPAIN	
	SWEDEN	
	UNITED KINGDOM	
Nuts1_apiary[24]	BE1	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest
	BE2	Vlaams Gewest
	BE3	Région Wallonne
	DE1	Baden-Württemberg
	DE2	Bayern
	DE3	Berlin
	DE4	Brandenburg
	DE7	Hessen
	DE8	Mecklenburg-Vorpommern
	DE9	Niedersachsen
	DEA	Nordrhein-Westfalen
	DEB	Rheinland-Pfalz
	DED	Sachsen
	DEE	Sachsen-Anhalt
	DEG	Thüringen
	DK0	Danmark
	EE0	Eesti
	EL1	Voreia Ellada
	EL2	Kentriki Ellada
	EL3	Attiki
	EL4	Nisia Aigaiou, Kriti
	ES1	Noroeste
	ES2	Noreste
	ES3	Comunidad de Madrid
	ES4	Centro
	ES5	Este
	ES6	Sur
	ES7	Canarias
	FI1	Manner-Suomi
	FI2	Åland
	FR2	Bassin Parisien
	FR4	Est
	FR5	Ouest
	FR7	Centre-Est
	FR8	Méditerranée
	HU1	Közép-Magyarország
	HU2	Dunàntùl
	HU3	Alföld és Észak
	ITC	Nord-Ovest
	ITF	Sud
	ITG	Isole
	ITH	Nord-Est
	ITI	Centro
	LT0	Lietuva
	LV0	Latvija
	PL1	Region Centralny
	PL2	Region Południowy
	PL3	Region Wschodni
	PL4	Region Północno-Zachodni
	PL5	Region Południowo-Zachodni
	PT1	Continente
	SE1	Östra Sverige
	SE2	Södra Sverige
	SK0	Slovensko
	UKC	North East (England)
	UKD	North West (England)
	UKE	Yorkshire and the Humber
	UKF	East Midlands (England)

[24] For readibilty, the different countries were highlighted in different colours.

	UKG	West Midlands (England)
	UKH	East of England
	UKI	London
	UKJ	South East (England)
	UKK	South West (England)
	UKL	Wales
Nuts2_apiary[25]	BE10	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest
	BE21	Provincie van Antwerpen
	BE22	Provincie van Limburg
	BE23	Provincie van Oost-Vlaanderen
	BE24	Provincie van Vlaams-Brabant
	BE25	Provincie van West-Vlaanderen
	BE31	Province de Brabant Wallon
	BE32	Province de Hainaut
	BE33	Province de Liège
	BE34	Province de Luxembourg
	BE35	Province de Namur
	DE11	Stuttgart
	DE12	Karlsruhe
	DE13	Freiburg
	DE14	Tübingen,Landkreis
	DE22	Niederbayern
	DE23	Oberpfalz
	DE24	Oberfranken
	DE25	Mittelfranken
	DE26	Unterfranken
	DE27	Schwaben
	DE30	Berlin
	DE40	Brandenburg
	DE71	Darmstadt
	DE72	Gießen
	DE73	Kassel
	DE80	Mecklenburg-Vorpommern
	DE91	Braunschweig
	DE92	Hannover
	DE93	Lüneburg
	DE94	Weser-Ems
	DEA1	Düsseldorf
	DEA2	Köln
	DEA3	Münster
	DEA5	Arnsberg
	DEB1	Koblenz
	DEB2	Trier
	DEB3	Rheinhessen-Pfalz
	DED2	Dresden
	DED4	Chemnitz
	DED5	Leipzig
	DEE0	Sachsen-Anhalt
	DEG0	Thüringen
	DK01	Hovedstaden
	DK02	Sjaelland
	DK03	Syddanmark
	DK04	Midtjylland
	DK05	Nordjylland
	EE00	Eesti
	EL11	Anatokili Makedonia, Thraki
	EL12	Kentriki Mekedonia
	EL13	Dikity Macedonia
	EL14	Thessalia

[25] For readibilty, the different countries were highlighted in different colours

	EL21	Ipeiros
	EL22	Ionia Nisia
	EL23	Dytiki Ellada
	EL24	Sterea Ellada
	EL25	Peloponnisos
	EL30	Attiki
	EL41	Voreio Aigaio
	EL42	Notio Aigaio
	EL43	Kriti
	ES11	Galicia
	ES12	Principado de Asturias
	ES21	País Vasco
	ES22	Communidad Foral de Navarra
	ES23	La Rioja
	ES24	Aragón
	ES41	Castilla y León
	ES42	Castilla-La Mancha
	ES43	Extremadura
	ES51	Cataluña
	ES52	Comunidad Valenciana
	ES61	Andalucía
	ES62	Región de Murcia
	ES70	Canarias
	FI19	Länsi-Suomi
	FI1B	Helsinki-Uusimaa
	FI1C	Etelä-Suomi
	FI1D	Pohjois-ja Itä-Suomi
	FI20	Åland
	FR24	Centre
	FR42	Alsace
	FR52	Bretagne
	FR71	Rhône-Alpes
	FR72	Auvergne
	FR82	Provence-Alpes-Côte d'Azur
	HU10	Közép-Magyarország
	HU21	Közép-Dunàntùl
	HU22	Nyugat-Dunàntùl
	HU23	Dél-Dunàntùl
	HU31	Észak-Magyarország
	HU32	Észak-Alföld
	HU33	Dél-Alföld
	ITC1	Piemonte
	ITC2	Valle d'Aosta
	ITC3	Liguria
	ITC4	Lombardia
	ITF1	Abruzzo
	ITF2	Molise
	ITF3	Campania
	ITF4	Puglia
	ITF5	Basilicata
	ITF6	Calabria
	ITG1	Sicilia
	ITG2	Sardegna
	ITH1	Provincia Autonoma di Bolzano
	ITH2	Provincia Autonoma di Trento
	ITH3	Veneto
	ITH4	Friuli-Venezia Giulia
	ITH5	Emilia-Romagna
	ITI1	Toscana
	ITI2	Umbria
	ITI3	Marche

	ITI4	Lazio
	LT00	Lietuva
	LV00	Latvija
	PL11	Województwo Łódzkie
	PL22	Województwo Śląskie
	Pl31	Województwo Lubelskie
	PL43	Województwo Lubuskie
	PL51	Województwo Dolnośląskie
	PT11	Norte
	PT15	Algarve
	PT16	Centro
	PT17	Lisboa
	PT18	Alentejo
	SE11	Stockholm
	SE12	Östra Mellansverige
	SE22	Sydsverige
	SE23	Västsverige
	SK01	Bratislavský kraj
	SK02	Zàpadné Slovensko
	SK03	Stredné Slovensko
	SK04	Východné Slovensko
	UKC1	Tees Valley and Durham
	UKC2	Northumberland and Tyne and Wear
	UKD1	Cumbria
	UKD3	Greater Manchester
	UKD4	Lancashire
	UKD6	Cheshire West and Chester
	UKD7	Meseyside
	UKE1	East Torkshire and Nothern Lincolnshire
	UKE2	North Yorkshire
	UKE3	South Yorkshire
	UKE4	West Yorkshire
	UKF1	Derbyshire and Nottinghamshire
	UKF2	Leicestershire, Rutland and Northamptonshire
	UKF3	Lincilnshire
	UKG1	Herefordshire, Worcestershire and Warwickshire
	UKG2	Shropshire and Staffordshire
	UKG3	West Midlands
	UKH1	East Angila
	UKH2	Bedfordshire and Hertfordshire
	UKH3	Essex
	UKI2	Outer London
	UKJ1	Berkshire, Buckinghamshire and Oxfordshire
	UKJ2	Surrey, East and West Sussex
	UKJ3	Hampshire ans Isle of Wight
	UKJ4	Kent
	UKK1	Gloucestershire, Wiltshire ans Bristol/Bath area
	UKK2	Dorset and Somerset
	UKK3	Cornwall ans Isles of Scilly
	UKK4	Devon
	UKL1	West Wales ans The Valleys
	UKL2	East Wales
Nuts3_apiary[26]	BE100	Arrrondissement administratif de Bruwelles-Capitale / Administratief arrondissement van Brussel-Hoofdstad
	BE211	Administratief arrondissement van Antwerpen
	BE212	Administratief arrondissement van Mechelen
	BE213	Administratief arrondissement van Turnhout
	BE221	Administratief arrondissement van Hasselt
	BE222	Administratief arrondissement van Masseik

[26] For readibilty, the different countries were highlighted in different colours

BE223	Administratief arrondissement van Tongeren
BE231	Administratief arrondissement van Aalst
BE232	Administratief arrondissement van Dendermonde
BE233	Administratief arrondissement van Eelko
BE234	Administratief arrondissement van Gent
BE235	Administratief arrondissement van Oudenaarde
BE236	Administratief arrondissement van Sint-Niklaas
BE241	Administratief arrondissement van Halle-Vilvoorde
BE242	Administratief arrondissement van Leuven
BE251	Administratief arrondissement van Brugge
BE252	Administratief arrondissement van Diksmuide
BE253	Administratief arrondissement van Leper
BE254	Administratief arrondissement van Kortijk
BE255	Administratief arrondissement van Oostende
BE256	Administratief arrondissement van Roeselare
BE257	Administratief arrondissement van Tielt
BE258	Administratief arrondissement van Veurne
BE310	Arrondissement administratif de Nivelles
BE321	Arrondissement administratif de Ath
BE322	Arrondissement administratif de Charleroi
BE323	Arrondissement administratif de Mons
BE324	Arrondissement administratif de Mouscron
BE325	Arrondissement administratif de Soignies
BE326	Arrondissement administratif de Thuin
BE327	Arrondissement administratif de Tournai
BE331	Arrondissement administratif de Huy
BE332	Arrondissement administratif de Liège
BE334	Arrondissement administratif de Waremme
BE335	Arrondissement de Verviers - Communes Francophones
BE336	Bezirk Verviers - Deutschsprachige Gemeinschaft
BE341	Arrondissement administratif de Arlon
BE342	Arrondissement administratif de Bastogne
BE343	Arrondissement administratif de Marche-en-Famenne
BE344	Arrondissement administratif de Neufchâteau
BE345	Arrondissement administratif de Virton
BE351	Arrondissement administratif de Dinant
BE352	Arrondissement administratif de Namur
BE353	Arrondissement administratif de Philippeville
DE111	Stuttgart, Stadtkreis
DE112	Böblingen
DE113	Esslingen
DE114	Göppingen
DE115	Ludwigsburg
DE116	Rems-Murr-Kreis
DE117	Heilbronn, Stadtkreis
DE11A	Schwäbisch Hall
DE11B	Main-Tauber-Kreis
DE11C	Heindenheim
DE122	Karlsrhue, Stadtkreis
DE123	Karlsrhue, Landkreis
DE126	Mannheim, Stadtkreis
DE127	Neckar-Odenwald-Kreis
DE128	Rhein-Neckar-Kreis
DE12A	Calw
DE12B	Enzkreis
DE12C	Freudenstadt
DE132	Breisgau-Hachschwarzwald
DE134	Ortenaukreis
DE136	Schwarzwald-Baar-Kreis
DE138	Konstanz
DE139	Lörrach

DE142	Tübingen,Landkreis
DE143	Zollernalbkreis
DE145	Alb-Donau-Kreis
DE146	Biberach
DE147	Bodenseekreis
DE224	Deggendorf
DE225	Freyung-Grafenau
DE226	Kelheim
DE227	Landshut, Landkreis
DE228	Passau, Landkreis
DE229	Regen
DE22A	Rottal-Inn
DE22B	Straubing-Bogen
DE231	Amberg, Kreisfreie Stadt
DE234	Amberg-Sulzbach
DE236	Neumarkt i. d. OPf.
DE237	Neustadt a. d. Waldnaab
DE239	Schwandorf
DE242	Bayreuth, Kreisfreie Stadt
DE243	Coburg, Kreisfreie Stadt
DE245	Bamberg, Landkreis
DE246	Bayreuth, Landkreis
DE247	Coburg, Landkreis
DE249	Hof, Landkreis
DE24C	Lichtenfels
DE24D	Wunsiedel i. Fichtelgebirge
DE252	Erlangen, Kreisfreie Stadt
DE253	Fürth, Kreisfreie Stadt
DE256	Ansbach, Landkreis
DE257	Erlangen-Höchstadt
DE259	Nürnberger Land
DE25C	Weißenburg-Gunzenhausen
DE266	Rhön-Grabfeld
DE267	Haßberge
DE268	Kitzingen
DE26A	Main-Spessart
DE275	Aichach-Friedberg
DE276	Augsburg, Landkreis
DE278	Günzburg
DE27C	Unterallgäu
DE27E	Oberallgäu
DE300	Berlin
DE408	Havelland
DE405	Barnim
DE409	Märkisch-Oderland
DE40A	Oberhavel
DE40D	Ostprignitz-Ruppin
DE713	Offenbach am Main, Kreisfreie Stadt
DE715	Bergstraße
DE716	Darmstadt-Dieburg
DE717	Groß-Gerau
DE718	Hochtaunuskreis
DE719	Main-Kinzing-Kreis
DE71A	Main-Taunus-Kreis
DE71B	Odenwaldkreis
DE71C	Offenbach, Landkreis
DE71D	Rheingau-Taunus-Kreis
DE71E	Wetteraukreis
DE721	Gießen,Landkreis
DE722	Lahn-Dill-Kreis
DE723	Limburg-Weilburg

DE724	Marburg-Biedenkopf
DE725	Vogelsbergkreis
DE732	Fulda
DE733	Hersfeld-Rotenburg
DE734	Kassel, Landkreis
DE735	Schwalm-Eder-Kreis
DE736	Waldeck-Frankenberg
DE737	Werra-Meißner-Kreis
DE801	Greifswald, Kreisfreie Stadt
DE803	Rostock, Kreisfreie Stadt
DE80B	Mecklenburg-Strelitz
DE80C	Müritz
DE80F	Ostvorpommern
DE80I	Uecker-Randow
DE911	Braunschweig, Kreisfreie Stadt
DE913	Wolfsburg, Kreisfreie Stadt
DE914	Gifhorn
DE916	Goslar
DE918	Northheim
DE922	Diepholz
DE923	Hameln-Pyrmont
DE926	Holzminden
DE928	Schaumburg
DE929	Region Hannover
DE931	Celle
DE934	Lüchow-Dannenberg
DE935	Lüneburg, Landkreis
DE936	Osterholz
DE938	Soltau-Fallingbostel
DE93A	Uelzen
DE943	Oldenburg, Kreisfreie Stadt
DE946	Ammerland
DE949	Emsland
DE94D	Oldenburg, Landkreis
DE94E	Osnabrück, Landkreis
DEA12	Duisburg, Kreisfreie Stadt
DEA1C	Mettmann
DEA28	Euskirchen
DEA2C	Rhein-Sieg-Kreis
DEA2D	Städteregion Aachen
DEA34	Borken
DEA5A	Siegen-Wittgenstein
DEA5B	Soest
DEA5C	Unna
DEB14	Bad Kreuznach
DEB16	Cochem-Zell
DEB17	Mayen-Koblenz
DEB19	Rhein-Hunsrück-Kreis
DEB1A	Rhein-Lahn-Kreis
DEB1B	Westerwaldkreis
DEB21	Trier, Kreisfreie Stadt
DEB22	Bernkastel-Wittlich
DEB23	Eifelkreis Bitburg-Prüm
DEB25	Trier-Saarburg
DEB33	Landau in der Pfalz, Kreisfreie Stadt
DEB38	Speyer, Kreisfreie Stadt
DEB39	Worms, Kreisfreie Stadt
DEB3B	Alzey-Worms
DEB3E	Germersheim
DEB3F	Kainserslautern, Landkreis
DEB3J	Mainz-Bingen

DEB3K	Südwestpfalz
DED2E	Meißen
DED41	Chemnitz, Kreisfreie Stadt
DED42	Erzgebirgskreis
DED43	Mittelsachsen
DED45	Zwichau
DED51	Leipzig, Kreisfreie Stadt
DEE02	Halle, Kreisfreie Stadt
DEE04	Altmarkkreis Salzwedel
DEE05	Anhalt-Bitterfeld
DEE08	Burgenland
DEE0B	Saalekreis
DEE0C	Salzlandkreis
DEE0D	Stendal
DEE0E	Wittenberg
DEG03	Jena, Kreisfreie Stadt
DEG05	Weimar, Kreisfreie Stadt
DEG09	Unstrut-Hainich-Kreis
DEG0F	Ilm-Kreis
DEG0H	Sonneberg
DEG0I	Saalfeld-Rudolstadt
DEG0L	Greiz
DK011	Byen København
DK012	Københavns omegn
DK013	Nordsjaelland
DK014	Bornholm
DK021	Østsjaelland
DK022	Vest-og Sydsjaelland
DK031	Fyn
DK032	Sydjylland
DK041	Vestjylland
DK042	Østjylland
DK050	Nordjylland
EE001	Põhja
EE004	Lääne
EE006	Kesk
EE007	Kirde
EE008	Lõuna
EL111	Evros
EL113	Rodopi
EL114	Drama
EL115	Kavala
EL121	Imathia
EL122	Thessaloniki
EL123	Kilkis
EL125	Pieria
EL126	Serres
EL127	Chalkidiki
EL131	Grevena
EL133	Kozani
EL134	Florina
EL141	Kardista
EL142	Larista
EL143	Magnisia
EL144	Trikala
EL211	Arta
EL212	Thesprotia
EL213	Ionnina
EL214	Preveza
EL221	Zakynthos
EL222	Kerkyra

EL223	Kefallinia
EL231	Aitoloakarnania
EL232	Achaia
EL241	Voiotia
EL242	Evvoia
EL245	Fokida
EL251	Argolida
EL252	Arkadia
EL253	Korinthia
EL254	Lakonia
EL255	Messinia
EL300	Attiki
EL411	Lesvos
EL413	Chios
EL421	Dodekanisos
EL422	Kyklades
EL431	Irakleio
EL432	Lasithi
EL433	Rethimni
EL434	Chania
ES111	A Coruña
ES112	Lugo
ES113	Ourense
ES114	Pontevedra
ES120	Asturias
ES211	Alava
ES212	Guipuzcoa
ES213	Vizcaya
ES220	Navarra
ES230	La Rioja
ES241	Huesca
ES242	Teruel
ES243	Zaragoza
ES411	Ávila
ES412	Burgos
ES413	León
ES414	Palencia
ES415	Salamanca
ES416	Segovia
ES417	Soria
ES418	Valladolid
ES419	Zamora
ES421	Albacete
ES422	Ciudad Real
ES423	Cuenca
ES424	Guadalajara
ES425	Toledo
ES431	Badajoz
ES432	Càceres
ES511	Barcelona
ES512	Girona
ES513	Lleida
ES514	Tarragona
ES521	Alicante
ES522	Castellón
ES523	Valencia
ES611	Almería
ES612	Càdiz
ES613	Córdoba
ES614	Granada
ES615	Huelva

ES616	Jaén
ES617	Màlaga
ES618	Sevilla
ES620	Murcia
ES705	Gran Canaria
ES709	Tenerife
FI194	Etelä-Pohjanmaa
FI195	Pohjanmaa
FI196	Satakunta
FI197	Pirkanmaa
FI1B1	Helsinki-Uusimaa
FI1C1	Varsinais-Suomi
FI1C2	Kanta-Häme
FI1C3	Päijät-Häme
FI1D1	Etelä-Savo
FI1D2	Pohjois-Savo
FI1D3	Pohjois-Karjala
FI1D4	Kainuu
FI1D6	Pohjois-Pohjanmaa
FI200	Åland
FR244	Indre-et-Loire
FR422	Haut-Rhin
FR522	Finistère
FR713	Drôme
FR722	Cantal
FR824	Bouches-du-Rhône
HU102	Pest
HU211	Fejér
HU212	Komàrom-Esztergom
HU213	Veszprém
HU221	Gyõr-Moson-Sopron
HU222	Vas
HU223	Zala
HU231	Baranya
HU232	Somogy
HU233	Tolna
HU311	Borsod-Abaùj-Zemplén
HU312	Heves
HU313	Nógràd
HU321	Hajdù-Bihar
HU322	Jàsz-Nagykun-Szolnok
HU323	Szabolcs-Szatmar-Bereg
HU331	Bàcs-Kiskun
HU332	Békés
HU333	Csongràd
ITC11	Torino
ITC12	Vercelli
ITC13	Biella
ITC14	Verbano-Cusio-Ossola
ITC15	Novara
ITC16	Cuneo
ITC17	Asti
ITC18	Allessandria
ITC20	Valle d'Aosta
ITC31	Imperia
ITC32	Savona
ITC33	Genova
ITC34	La Spezia
ITC41	Varese
ITC42	Como
ITC43	Lecco

ITC44	Sondrio
ITC46	Bergamo
ITC47	Brescia
ITC48	Pavia
ITC49	Lodi
ITC4A	Cremona
ITC4B	Mantova
ITC4C	Milano
ITC4D	Monza e delba Brianza
ITF11	L'Aquila
ITF12	Teramo
ITF13	Pescara
ITF14	Chieti
ITF21	Isernia
ITF22	Campobasso
ITF31	Caserta
ITF32	Benevento
ITF33	Napoli
ITF34	Avellino
ITF35	Salerno
ITF43	Taranto
ITF44	Brindisi
ITF45	Lecce
ITF46	Foggia
ITF47	Bari
ITF48	Barletta-Andria-Tani
ITF51	Potenza
ITF52	Matera
ITF61	Cosenza
ITF63	Catanzaro
ITF64	Vibo Valentina
ITF65	Reggio di Calabria
ITG11	Trapani
ITG12	Palermo
ITG13	Messina
ITG14	Agrigento
ITG15	Caltanisseta
ITG16	Enna
ITG17	Catania
ITG18	Ragusa
ITG19	Siracusa
ITG25	Sassari
ITG27	Cagliari
ITG28	Oristano
ITG29	Olbia-Tempio
ITG2B	Medio Campidano
ITG2C	Carbonia-Iglesias
ITH10	Bolzano
ITH20	Trento
ITH31	Verona
ITH32	Vicenza
ITH33	Belluno
ITH34	Treviso
ITH35	Venezia
ITH36	Padova
ITH37	Rovigo
ITH41	Pordenone
ITH42	Udine
ITH43	Gorizia
ITH51	Piacenza
ITH52	Parma

ITH53	Reggio nell'Emilia
ITH54	Modena
ITH55	Bologna
ITH56	Ferrara
ITH57	Ravenna
ITH58	Forli-Cesena
ITH59	Rimini
ITI11	Massa-Carrara
ITI12	Lucca
ITI13	Pistoia
ITI14	Firenze
ITI15	Prato
ITI16	Livorno
ITI17	Pisa
ITI18	Arezzo
ITI19	Siena
ITI1A	Grosseto
ITI21	Perugia
ITI22	Terni
ITI31	Pensaro e Urbino
ITI32	Ancona
ITI33	Macerata
ITI34	Ascoli Piceno
ITI35	Fermo
ITI41	Viterbo
ITI42	Rieti
ITI43	Roma
ITI44	Latina
ITI45	Frosinone
LT001	Alytaus apskritis
LT002	Kauno apskritis
LT003	Klaipėdos apskritis
LT004	Marijampolės apskritis
LT005	Panevėžio apskritis
LT006	Šiaulių apskritis
LT007	Tauragės apskritis
LT008	Telšių apskritis
LT009	Utenos apskritis
LT00A	Vilniaus apskritis
LV003	Kurzeme
LV005	Latgale
LV006	Rïga
LV007	Pierïga
LV008	Vidzeme
LV009	Zemgale
PL115	Podregion Piotrkowski
PL22C	Podregion Tyski
PL311	Podregion Bialski
PL312	Podregion Chełmsko-zamojski
PL313	Podregion Puławski
PL314	Podregion Lubelski
PL431	Podregion Gorzowski
PL516	Podregion Legnicko-Głogowski
PT111	Minho-Lima
PT112	Càvado
PT113	Avellino
PT114	Grande Porto
PT115	Tâmega
PT117	Douro
PT118	Alto Tràs-os-Montes
PT150	Algarve

PT161	Baixo Vouga
PT162	Baixo Mondego
PT163	Pinhal Litoral
PT164	Pinhal Intetrior Norte
PT165	Dão-Lafões
PT167	Pinhal Interior Sul
PT168	Serra da Estrela
PT169	Beira Interior Sul
PT16A	Cova da Beira
PT16B	Oeste
PT16C	Médio Tejo
PT171	Grande Lisboa
PT172	Peninsula de Setùbal
PT181	Alentejo Litoral
PT182	Alto Alentejo
PT183	Alentejo Central
PT184	Baixo Alentejo
PT185	Lezíria do Tejo
SE110	Stockholms län
SE121	Uppsala län
SE224	Skåne län
SE232	Västra Götalands län
SK010	Bratislavský kraj
SK021	Trnavský kraj
SK022	Trenčiansky kraj
SK023	Nitriansky kraj
SK031	Žilinský kraj
SK032	Banskobystrický kraj
SK041	Prešovský kraj
SK042	Košický kraj
UKC14	Durham CC
UKC21	Northumberland
UKC22	Tyneside
UKD11	West Cumbria
UKD12	East Cumbria
UKD32	Greater Manchester North
UKD41	Blackburn with Darwen
UKD43	Lancashire CC
UKD61	Warrington
UKD63	Cheshire West and Chester
UKD72	Liverpool
UKE11	Kingston upon Hull
UKE21	York
UKE22	North Yorkshire CC
UKE31	Barnsley,Doncaster and Rotherham
UKE41	Bradford
UKE42	Leeds
UKF11	Derby
UKF12	East Derbyshire
UKF13	South and West Derbyshire
UKF14	Nottingham
UKF15	North Nottinghashire
UKF16	Soth Nottinghamshire
UKF21	Leicester
UKF22	Leicestershire CC and Rutland
UKF24	West Northamptonshire
UKF25	North Northamptonshire
UKF30	Lincolnshire
UKG11	Herefordshire
UKG12	Worcestershire
UKG13	Warwickshire

	UKG21	Telford and Wrekin
	UKG22	Shropshire CC
	UKG24	Staffordshire CC
	UKG31	Birmingham
	UKG39	Wolverhampton
	UKH11	Peterborought
	UKH12	Cambridgeshire CC
	UKH13	Norfolk
	UKH14	Suffolk
	UKH21	Luton
	UKH23	Hertfordshire
	UKH33	Essex CC
	UKI21	Outer London - East and North East
	UKI22	Outer London - South
	UKI23	Outer London - West and North West
	UKJ11	Berkshire
	UKJ12	Milton Keynes
	UKJ13	Buckinghamshire CC
	UKJ14	Oxfordshire
	UKJ22	Esast Sussex CC
	UKJ23	Surrey
	UKJ24	West Sussex
	UKJ33	Hampshire CC
	UKJ34	Isle of Wight
	UKJ42	Kent CC
	UKK11	Bristol
	UKK12	Bath and North East Somerset, North Somerset and South Gloucestershire
	UKK13	Gloucestershire
	UKK15	Wiltshire CC
	UKK21	Bournemouth and Poole
	UKK22	Dorset CC
	UKK23	Somerset
	UKK30	Cornwall and Isles of Scilly
	UKK41	Plymouth
	UKK43	Devon CC
	UKL12	Gwynedd
	UKL13	Conwy and Denbighshire
	UKL14	South West Wales
	UKL15	Central Valleys
	UKL16	Gwent Valleys
	UKL18	Swansea
	UKL22	Cardiff and Vale of Glamorgan
	UKL23	Flintshire and Wrexham
	UKL24	Powys
Migration	Yes	
	No	
Apiary_size	Number from 0 and 1000	
Production[27]	Honey	
	Pollen	
	Pollination Services	
	Queens	
	Royal jelly	
	Swarms	
	Honey + Pollen	
	Honey + Pollination Services	
	Honey + Queens	
	Honey + Royal jelly	
	Honey + Swarms	
	Queens + Swarms	
	Honey + Pollen + Pollination Services	

[27] For readibilty, the different categories were highlighted in different colours

	Honey + Pollen + Queens
	Honey + Pollen + Royal jelly
	Honey + Pollen + Swarms
	Honey + Pollination Services + Queens
	Honey + Pollination Services + Swarms
	Honey + Queens + Swarms
	Honey + Queens + Royal jelly
	Honey + Royal jelly + Swarms
	Pollen + Pollination Services + Queens
	Honey + Pollen + Pollination Services + Queens
	Honey + Pollen + Pollination Services + Royal jelly
	Honey + Pollen + Pollination Services + Swrams
	Honey + Pollen + Queens + Royal jelly
	Honey + Pollen + Queens + Swarms
	Honey + Pollen + Royal jelly + Swarms
	Honey + Pollination Services + Queens + Swarms
	Honey + Queens + Royal jelly + Swarms
	Honey + Pollen + Pollination Services + Queens + Royal jelly
	Honey + Pollen + Queens + Royal jelly + Swarms
	Honey + Pollen + Pollination Services + Queens + Royal jelly + Swarms
Env_farmland	Yes
	No
Type_farmland	788 different categories (EU) / 59 different categories (SP)
Env_orchards	Yes
	No
Specie_orchards	422 different categories (EU) / 59 different categories (SP)
Env_flora	Yes
	No
Env_wood	Yes
	No
Env_town	Yes
	No
Env_indus	Yes
	No
Env_other	Yes
	No
Apiarist_book	Yes
	No
Queen_import	Yes
	No
Queen_import_or	Argentina
	Chile
	Other
	No (BE)
Queen_import_or_2	Argentina
Harbor	Yes
	No
Airport	Yes
	No

COLONY table (green and yellow categories from the criterion #1)

Field_ID	36 532 different categories (EU)
	Between 1 and 6 (BE)
	Between 1 and 13 (SP)
Reason	Extra colony
	Randomly selected colony
Strength_colonie	0
	1
	2
	3
	4
	5

DISEASE table (green and yellow categories from the criterion #1)

Suspected	American Foulbrood
	Chronic Paralysis
	European Foulbrood
	Nosemosis
	Other
	Small Hive beetle
	Tropilaelaps spp
	Varroosis
Date	Between Autum/02-08-2012 and Summer/31-08-2014

HEALTH table

There was no variable classified in green or yellow (from the criterion #1) in the table HEALTH.

MANAGEMENT table (green and yellow categories from the criterion #1)

Management	Increase the livestock
	Increase the production
	Increase the livestock and the production
	Maintain the livestock
	Maintain the livestock and increase the livestock
	To improve the health conditions
Swram_bought	Number from 0 and 456
Swram_produced	Number from 0 and 1000
Queen_bought	Nulmberr from 0 and 5656
Queen_produced	Number from 0 and 5000
Date action	Between 1st January 2012 and 1st January 2015
Colonie_divided	Number from 0 and 600
Colonie_naturally	Number from 0 and 100
Colonie_merged	Number from 0 and 210

MIGRATION table

There was no variable classified in green or yellow (from the criterion #1) in the table MIGRATION.

RESULTS table (green and yellow categories from the criterion #1)

Apiary	Yes
Lab_ID	42 258 different categories (EU) / 5288 different categories (SP) / 62 different categories (BE)
Analysis	ABPV detection
	Acarapis woodi
	American Foulbrood
	Ascosphera apis
	BQCV
	Chronic Paralysis
	DWV detection
	European Foulbrood
	IAPV
	KBV
	Nosema typing
	Nosemosis

	SBV
	Small Hive Beetle
	Tropilaelaps spp
	Varroa counting
	Varroosis
Technique	Antigenetic detection
	Bacteriologic culture
	Biochemical tests
	Conventionnal PCR
	Latral flow test
	Macroscopic observation
	On the field diagnostic
	Optical microscopy
	Quantitative real time PCR
	Real time PCR
	Real time PCR (qualitative)
Result	Analysis not possible
	Negative
	Positive
	Results not usable
	See details
Detail	5178 different categories (EU)
	Number from 0.1 and 1.74E+09 (SP)
	Galeria mellonera (SP)
	Nosema apis (SP)
	Nosema apis + Nosema ceranae (SP)
	Nosema ceranae (SP)
	Vespa velutina (SP)
	Number from 0.17 and 92 (BE)
	per 100 bee larves (BE)
Date	Between 15th April 2011 and 21st February 2015
Number_nosema	Number from 0 and 58 100 000
Number_varroa	Number from 0 and 214

SAMPLE table (green and yellow categories from the criterion #1)

Reason	Suspect parasites
	Symptomatic brood
	Symptomatic honeybees (20 per sample)
	Systematic honeybees (300 per sample)
Nature	Beetle
	Beetle larva
	Dead honeybees
	Larvae, nymphs, scales
	Living externals honeybees
	Living internals honeybees
	Mites
	Piece of brood (frame)
Date_V	Between Autumn/02-08-2012 and Summer/31-08-2014
Field_ID	73 498 different categories (EU) / 7631 different categories (SP) / 671 different categories (BE)

STRENGTH table (green and yellow categories from the criterion #1)

Dead	Yes
	No
Force	0
	1
	2
	3
	4
	5

Date	Between Autumn/01-08-2013 and Spring/31-08-2014
Future	Merged colony
	Other reason
	Sold/given colony
Type	Extra colony
	Randomly selected colony
Varroosis	Yes

SYMPTOMS table (green and yellow categories from the criterion #1)

Symptom	Black shiny honneybees
	Black shiny honneybees rejected from the hive
	Brood and honney destruction
	Cannibalism on larvae or on pupae
	Crawling honeybees, bees clinging to the grass
	Dead colony
	Dead honeybees back of the hive
	Dead honeybees in fornt of the hive
	Dead honeybees within cells
	Doubtul clinical signs (please specify on remark)
	Galeries inside the frames
	Honey bees with deformed and/or atrophied wings
	Impeded/Occupied flight board
	Larvae with yellowish to brown colour
	Merged colony
	Nervous symptoms, disorientation, with little movement and no aggression
	Occupied flight board
	Phoretic beetles, unusual larvae or eggs
	Phoretic varroa
	Ropy larvae
	Slumped larvae
	Sold/given colony
	Specific odor of AFB
	Spooty brood pattern
	Starvation
	Suspect atypical mite
	Traces of diarrhea
	Trembling honneybees
Date	Between Autumn/02-08-2014 and Summer/31-07-2014

TREATMENT table (green and yellow categories from the criterion #1)

Date_treat	Between 10th October 2009 and the 1st January 2015
Name_treat	768 different categories (EU) / 29 different categories (SP) / 34 different categories (BE)
Frequence	Number from 0 and 20
Treatment_correctly	Yes
	No

VISIT table (green and yellow categories from the criterion #1)

Date	Between 1st August 2012 and 29th November 2014
Rank	Autumn
	Spring
	Summer
Inspected	Number from 0 and 450
Random	Number from 0 and 56
Random_v1_rap	Number from 0 and 210

Alive_v2	Number from 0 and 56
Dead_v1_v2	Number from 0 and 23
Merged_v1_v2	Number from 0 and 19
sold_v1_v2	Number from 0 and 25
Divided_v1_v2	Number from 0 and 25
Alive_v3	Number from 0 and 56
Dead_v2_v3	Number from 0 and 13
Merged_v2_v3	Number from 0 and 13
sold_v2_v3	Number from 0 and 19
Divided_v2_v3	Number from 0 and 38
Previous_visit	Yes
	No
Moving_apiary	Apiary Moving
	Migration
During_visit	Number from 0 and 800
Visited_apiary	Number from 0 and 100
Farm_general	Number from 0 and 100
Produce_v1_v2	Number from 0 and 40
Produce_v2_v3	Number from 0 and 50

The 12 tables (blue and red categories from the criterion #1)

BEEKEEPER	**Surname**	3815 different categories (EU) / 223 different categories (SP)
	Postal adress	4632 different categories (EU) / 313 different categories (SP)
	City	3182 different categories (EU) / 236 different categories (SP)
	Tel	2757 different categories (EU)
	Fax	63 different categories (EU)
	E-mail	1147 different categories (EU)
	Org_member	Yes
		No
	Continue	Yes
		No
	Follower	Yes
		No
	LAU	2452 different categories (EU) / 308 different categories (SP) / 138 different categories (BE)
	Lat	4008 different categories (EU) / 368 different categories (SP) / 90 different categories (BE)
	Long	4084 different categories (EU) / 369 different categories (SP) / 108 different categories (BE)
	Breed	A. m. carnica
		A. m. carpatica
		A. m. caucasica
		A. m. iberiensis
		A. m. ligustica
		A. m. macedonica
		A. m. mellifera
		A. m. syriaca
		A. m. carnica + buckfast
		A. m. mellifera + buckfast
		Buckfast
		Hybrid
		Local bees
	Other_risk	85 different categories (EU) / 5 different categories (SP)
		No (BE)
DISEASE	**Remark**	489 different categories (EU) / 64 different categories (SP)
		deformed wings (BE)
HEALTH	**Type_event**	Chronic depopulation
		Clinical signs on broods
		Clinical signs on honeybees
		High rate of colony mortality (>10)
		High rate of honeybee mortality
		Other
		Presence of varroa mites on adult honeybees
		Queen problems
	Other	495 different categories (EU) / 25 different categories (SP)
	Disease_event	American Foulbrood
		Chronic paralysis
		European Foulbrood
		Nosemosis
		Other
		Small Hive beetle
		Tropilaelaps spp
		Varroosis
	Other_D	814 different categories (EU) / 156 different categories (SP)
	Percentage_affected	Number from 0 and 100
	Lab	Yes
		No
	Conclusion	American Foulbrood
		Chronic paralysis
		European Foulbrood
		Nosemosis
		Other
		Small Hive beetle

		Tropilaelaps spp
		Varroosis
	Other_C	ABPW
		Acarapis woodi
		Aspergillosis
		Chalk brood
		Drone layer hive
		DWV
		Harmless beetle
		No food
		Poisonning
		Positive
		SBV
		Varroa and Nosema
		Varroa and DWV
		Virus
		Winter mortity
	Treatment	455 different categories (EU) / 75 different categories (SP)
MANAGEMENT	Swarm_or	BELGIUM
		BELGIUM + ITALY
		DENMARK
		ESTONIA
		FINLAND
		FRANCE
		GERMANY
		GREECE
		HUNGARY
		ITALY
		LATVIA
		LITHUANIA
		NETHERLANDS
		POLAND
		PORTUGAL
		SLOVAKIA
		SPAIN
		SWEDEN
		UNITED KINGDOM
	Queen_or	ARGENTINA
		AUSTRIA
		BELGIUM
		BULGARIA
		CHILE
		CROATIA
		CZECH REPUBLIC
		DENMARK
		DENMARK + GERMANY
		ESTONIA
		FINLAND
		FRANCE
		GERMANY
		GREECE
		HUNGARY
		ITALY
		LATVIA
		LITHUANIA
		LUXEMBOURG
		NETHERLANDS
		NETHERLANDS + BELGIUM
		NORWAY
		Other
		POLAND

		PORTUGAL	
		RUSSIA	
		SLOVAKIA	
		SLOVENIA	
		SLOVENIA + GERMANY	
		SPAIN	
		SWEDEN	
		SWITZERLAND	
		SWITZERLAND + BELGIUM	
		UKRAINE	
		UNITED KINGDOM	
MIGRATION[28]	Start	Between 1st March 2011 and 1st September 2014	
	End	Between 1st July 2011 and 1st December 2014	
	Place1	BE2	Vlaams Gewest
		BE3	Région Wallonne
		DE2	Bayern
		DE8	Mecklenburg-Vorpommern
		DE9	Niedersachsen
		DEA	Nordrhein-Westfalen
		DEB	Rheinland-Pfalz
		DED	Sachsen
		DEE	Sachsen-Anhalt
		DEF	Schleswig-Holstein
		DEG	Thüringen
		DK0	Danmark
		EE0	Eesti
		ES1	Noroeste
		ES2	Noreste
		ES3	Comunidad de Madrid
		ES4	Centro
		ES5	Este
		ES6	Sur
		ES7	Canarias
		FI1	Manner-Suomi
		FI2	Åland
		FR2	Bassin Parisien
		FR4	Est
		FR5	Ouest
		FR6	Sud-Ouest
		FR7	Centre-Est
		FR8	Méditerranée
		HU1	Közép-Magyarország
		HU2	Dunàntùl
		HU3	Alföld és Észak
		HUZ	Extra-Regio
		ITC	Nord-Ovest
		ITF	Sud
		ITG	Isole
		ITH	Nord-Est
		ITI	Centro
		LT0	Lietuva
		LTZ	Extra-Regio
		LV0	Latvija
		PL3	Region Wschodni
		PL4	Region Północno-Zachodni
		SE1	Östra Sverige
		SE2	Södra Sverige
		SK0	Slovensko
		UKE	Yorkshire and the Humber

[28] For readibilty, the different countries were highlighted in different colours

		UKF	East Midlands (England)
		UKG	West Midlands (England)
		UKH	East of England
	Place2	BE21	Provincie van Antwerpen
		BE22	Provincie van Limburg
		BE23	Provincie van Oost-Vlaanderen
		BE24	Provincie van Vlaams-Brabant
		BE25	Provincie van West-Vlaanderen
		BE31	Province de Brabant Wallon
		BE32	Province de Hainaut
		BE33	Province de Liège
		BE35	Province de Namur
		DE23	Oberpfalz
		DE27	Schwaben
		DE80	Mecklenburg-Vorpommern
		DE91	Braunschweig
		DE92	Hannover
		DE93	Lüneburg
		DE94	Weser-Ems
		DEA5	Arnsberg
		DEB2	Trier
		DEB3	Rheinhessen-Pfalz
		DED2	Dresden
		DEE0	Sachsen-Anhalt
		DEF0	Schleswig-Holstein
		DEG0	Thüringen
		DK01	Hovedstaden
		DK02	Sjaelland
		DK03	Syddanmark
		DK04	Midtjylland
		DK05	Nordjylland
		EE00	Eesti
		ES11	Galicia
		ES13	Cantabria
		ES23	La Rioja
		ES24	Aragón
		ES30	Comunidad de Madrid
		ES41	Castilla y León
		ES42	Castilla-La Mancha
		ES43	Extremadura
		ES51	Cataluña
		ES52	Comunidad Valenciana
		ES61	Andalucía
		ES62	Región de Murcia
		ES70	Canarias
		FI1D	Pohjois-ja Itä-Suomi
		FI20	Åland
		FR24	Centre
		FR41	Lorraine
		FR42	Alsace
		FR43	Franche-Comté
		FR52	Bretagne
		FR62	Midi-Pyrénées
		FR71	Rhône-Alpes
		FR72	Auvergne
		FR82	Provence-Alpes-Côte d'Azur
		HU10	Közép-Magyarorszàg
		HU21	Közép-Dunàntùl
		HU22	Nyugat-Dunàntùl
		HU23	Dél-Dunàntùl
		HU31	Észak-Magyarorszàg

		HU32	Észak-Alföld
		HU33	Dél-Alföld
		HUZZ	Extra-Regio
		ITC1	Piemonte
		ITC2	Valle d'Aosta
		ITC3	Liguria
		ITC4	Lombardia
		ITF1	Abruzzo
		ITF2	Molise
		ITF3	Campania
		ITF4	Puglia
		ITF5	Basilicata
		ITF6	Calabria
		ITG1	Sicilia
		ITG2	Sardegna
		ITH3	Veneto
		ITH5	Emilia-Romagna
		ITI1	Toscana
		ITI3	Marche
		ITI4	Lazio
		LT00	Lietuva
		LTZZ	Extra-Regio
		LV00	Latvija
		PL31	Województwo Lubelskie
		PL43	Województwo Lubuskie
		SE11	Stockholm
		SE22	Sydsverige
		SE23	Västsverige
		SK01	Bratislavský kraj
		SK02	Zàpadné Slovensko
		SK03	Stredné Slovensko
		SK04	Východné Slovensko
		UKE2	North Yorkshire
		UKF1	Derbyshire and Nottinghamshire
		UKG1	Herefordshire, Worcestershire and Warwickshire
		UKH1	East of England
	Place3	BE221	Administratief arrondissement van Hasselt
		BE223	Administratief arrondissement van Tongeren
		BE232	Administratief arrondissement van Dendermonde
		BE233	Administratief arrondissement van Eelko
		BE234	Administratief arrondissement van Gent
		BE236	Administratief arrondissement van Sint-Niklaas
		BE242	Administratief arrondissement van Leuven
		BE251	Administratief arrondissement van Brugge
		BE253	LAdministratief arrondissement van Leper
		BE255	Administratief arrondissement van Oostende
		BE258	Administratief arrondissement van Veurne
		BE310	Arrondissement administratif de Nivelles
		BE334	Arrondissement administratif de Waremme
		BE351	Arrondissement administratif de Dinant
		BE352	Arrondissement administratif de Namur
		DE236	Neumarkt i. d. OPf.
		DE239	Schwandorf
		DE275	Aichach-Friedberg
		DE276	Augsburg, Landkreis
		DE80F	Ostvorpommern
		DE80I	Uecker-Randow
		DE913	Wolfsburg, Kreisfreie Stadt
		DE914	Gifhorn
		DE928	Schaumburg
		DE929	Region Hannover

		DE931	Celle
		DE934	Lüchow-Dannenberg
		DE935	Lüneburg, Landkreis
		DE936	Osterholz
		DE938	Soltau-Fallingbostel
		DE93A	Uelzen
		DE94D	Oldenburg, Landkreis
		DEB22	Bernkastel-Wittlich
		DEB33	Landau in der Pfalz, Kreisfreie Stadt
		DEB38	Speyer, Kreisfreie Stadt
		DEB3B	Alzey-Worms
		DEB3H	Südliche Weinstraße
		DEB3K	Südwestpfalz
		DED21	Dresden, Kreisfreie Stadt
		DED2E	Meißen
		DEE07	Börde
		DEE0A	Mansfeld-Südharz
		DEE0D	Stendal
		DEF08	Ostholstein
		DEG01	Erfurt, Kreisfreie Stadt
		DEG09	Unstrut-Hainich-Kreis
		DEG0F	Ilm-Kreis
		DEG0G	Weimarer Land
		DK013	Nordsjaelland
		DK014	Bornholm
		DK021	Østsjaelland
		DK022	Vest-og Sydsjaelland
		DK031	Fyn
		DK032	Sydjylland
		DK041	Vestjylland
		DK042	Østjylland
		DK050	Nordjylland
		EE001	Põhja
		EE004	Lääne
		EE006	Kesk
		EE008	Lõuna
		ES112	Lugo
		ES130	Cantabria
		ES230	La Rioja
		ES241	Huesca
		ES242	Teruel
		ES243	Zaragoza
		ES300	Madrid
		ES411	Ávila
		ES412	Burgos
		ES413	León
		ES414	Palencia
		ES415	Salamanca
		ES416	Segovia
		ES417	Soria
		ES418	Valladolid
		ES419	Zamora
		ES421	Albacete
		ES422	Ciudad Real
		ES423	Cuenca
		ES424	Guadalajara
		ES425	Toledo
		ES431	Badajoz
		ES432	Càceres
		ES511	Barcelona
		ES512	Girona

		ES513	LLeida
		ES514	Tarragona
		ES521	Alicante
		ES522	Castellón
		ES523	Valencia
		ES611	Almería
		ES612	Càdiz
		ES613	Córdoba
		ES614	Granada
		ES615	Huelva
		ES616	Jaén
		ES617	Màlaga
		ES618	Sevilla
		ES620	Murcia
		ES709	Tenerife
		FI1D1	Etelä-Savo
		FI1D2	Pohjois-Savo
		FI200	Åland
		FR244	Indre-et-Loire
		FR245	Loir-et-Cher
		FR413	Moselle
		FR421	Bas-Rhin
		FR422	Haut-Rhin
		FR432	Jura
		FR433	Haute-Saône
		FR522	Finistère
		FR623	Haute-Garonne
		FR711	Ain
		FR712	Ardèche
		FR713	Drôme
		FR714	Isère
		FR715	Loire
		FR717	Savoie
		FR722	Cantal
		FR812	Gard
		FR813	Hérault
		FR821	Alpe-de-Haute-Provence
		FR822	Hautes-Alpes
		FR824	Bouches-du-Rhône
		FR825	Var
		FR826	Vaucluse
		HU102	Pest
		HU211	Fejér
		HU212	Komàrom-Esztergom
		HU213	Veszprém
		HU221	Győr-Moson-Sopron
		HU222	Vas
		HU223	Zala
		HU231	Baranya
		HU232	Somogy
		HU233	Tolna
		HU311	Borsod-Abaùj-Zemplén
		HU312	Heves
		HU313	Nógràd
		HU321	Hajdù-Bihar
		HU322	Jàsz-Nagykun-Szolnok
		HU323	Szabolcs-Szatmar-Bereg
		HU331	Bàcs-Kiskun
		HU332	Békés
		HU333	Csongràd
		HUZZZ	Extra-Regio

		ITC11	Torino
		ITC12	Vercelli
		ITC13	Biella
		ITC16	Cuneo
		ITC18	Allessandria
		ITC20	Valle d'Aosta
		ITC32	Savona
		ITC33	Genova
		ITC41	Varese
		ITC42	Como
		ITC44	Sondrio
		ITC47	Brescia
		ITF14	Chieti
		ITF22	Campobasso
		ITF31	Caserta
		ITF32	Benevento
		ITF33	Napoli
		ITF34	Avellino
		ITF35	Salerno
		ITF46	Foggia
		ITF47	Bari
		ITF51	Potenza
		ITF52	Matera
		ITF61	Cosenza
		ITF65	Reggio di Calabria
		ITG11	Trapani
		ITG12	Palermo
		ITG13	Messina
		ITG14	Agrigento
		ITG15	Caltanisseta
		ITG16	Enna
		ITG17	Catania
		ITG18	Ragusa
		ITG19	Siracusa
		ITG26	Nuoro
		ITG27	Cagliari
		ITG28	Oristano
		ITG29	Olbia-Tempio
		ITG2A	Ogliastra
		ITG2B	Medio Campidano
		ITG2C	Carbonia-Iglesias
		ITH32	Vicenza
		ITH33	Belluno
		ITH34	Teviso
		ITH36	Padova
		ITH37	Rovigo
		ITH51	Piacenza
		ITH52	Parma
		ITH54	Modena
		ITH56	Ferrara
		ITH57	Ravenna
		ITH59	Rimini
		ITI12	Lucca
		ITI13	Pistoia
		ITI17	Pisa
		ITI1A	Grosseto
		ITI32	Ancona
		ITI34	Ascoli Piceno
		ITI41	Viterbo
		ITI43	Roma
		ITI44	Latina

		LT001	Alytaus apskritis
		LT002	Kauno apskritis
		LT003	Klaipėdos apskritis
		LT004	Marijampolės apskritis
		LT005	Panevėžio apskritis
		LT006	Šiaulių apskritis
		LT008	Telšių apskritis
		LT009	Utenos apskritis
		LT00A	Vilniaus apskritis
		LTZZZ	Extra-Regio
		LV003	Kurzeme
		LV005	Latgale
		LV006	Rïga
		LV007	Pierïga
		LV008	Vidzeme
		LV009	Zemgale
		PL314	Lubelski
		SE110	Stockholms län
		SE224	Skåne län
		SE232	Västra Götalands län
		SK010	Bratislavský kraj
		SK021	Trnavský kraj
		SK022	Trenčiansky kraj
		SK023	Nitriansky kraj
		SK031	Žilinský kraj
		SK032	Banskobystrický kraj
		SK041	Prešovský kraj
		SK042	Košický kraj
		UKE21	York
		UKF12	East Derbyshire
		UKG12	Worcestershire
		UKG13	Warwickshire
		UKH14	Suffolk
	MidSeason_Target	Acacia	
		Beans	
		Chestnut	
		Clover	
		Eucalyptus	
		Heather	
		Honeydew	
		Lavander	
		Lime	
		Multiflower	
		Orange	
		Orchards	
		Other	
		Rapeseed	
		Raspberry	
		Rosmary	
		Seed production	
		Sunflower	
		Thymus	
	Other	416 different categories (EU) / 94 different categories (SP)	
		Apples + cherries (BE)	
		Blueberries (BE)	
		Cherries (BE)	
		Courgette (BE)	
		Dendelion (BE)	
		Fruit (BE)	
	Colonie	Number from 0 and 100	
RESULTS	**Comment**	1373 different categories (EU) / 78 different categories (SP)	

		ABPV positive also (BE)
		BQCV + SBV positive also (BE)
		BQCV positive also (BE)
		BQCV + CBPV positive also (BE)
		CBPV positive also (BE)
		KBV positive also (BE)
		SBV positive also (BE)
SYMPTOMS	**Remark**	1362 different categories (EU) / 33 different categories (SP)
		Chronic Paralysis (BE)
		European foulbrood (BE)
		Nosemosis (BE)
		Varroosis (BE)
TREATMENT	**Ingredient**	937 different categories (EU) / 29 different categories (SP) / 38 different categories (BE)
	Posology	2110 different categories (EU) / 130 different categories (SP) / 127 different categories (BE)
	Duration	Number from 0 and 420
	Remark	2235 different records (EU)
VISIT	**Visitor1**	1320 different categories (EU) / 257 different categories (SP) / 18 different categories (BE)
	Visitor2	750 different categories (EU) / 66 different categories (BE)
	Km	Number from 0 and 1101
	Time	Between 0 and 720 / 00:25 and 04:35

E4: Criterion #4: Compilation : expert decision

Outcomes from the previous selections were refined taking into account results from all the criteria including the number of categories (see below). All the 138 variables were classified into variables selected and variables not selected for the statistical analysis .

Some variables needed to be transformed to meet statistical needs:

- there were 6 variables for the beekeeping environment: a new synthetic variable was created.
- some variables were used only to calculate the mortality.
- some variables were used to identify data from autumn, spring or summer visits.

Similarly tothe criterion #2 and the criterion #3, the results are presented in two categories: on the right the variables in the green and yellow categories (resulting from the criterion #1); on the left the variables in the blue and red categories (resulting from the criterion #1).

BEEKEEPER table

INCLUDED	
Age	Variable included.
Activity	Variable included.
Beekeep_for	Variable included.
Qualif	Variable included.
Training	Variable included.
Coop_treat	Variable included.
Bee_population_size	Variable included.
Country	Variable included.
Apiary_size	Variable included.
Production	Variable included.
Apiarist_book	Variable included.

TO BE TRANSFORMED	
Env_farmland	Used to create a new variable "Environment".
Env_orchards	Used to create a new variable "Environment".
Env_flora	Used to create a new variable "Environment".
Env_wood	Used to create a new variable "Environment".
Env_town	Used to create a new variable "Environment".
Env_indus	Used to create a new variable "Environment".
Nuts1_apiary	Used to analyse each country according to regional division, but not published in this report.
Nuts2_apiary	Used to analyse each country according to regional division, but not published in this report.
Nuts3_apiary	Used to analyse each country according to regional division, but not published in this report.

NOT INCLUDED	
Name	Irrelevant.
ZipCode	Irrelevant.
Identification	Irrelevant.
Apiaries	Redundant information with "Colonies" .
Migration	The informations in the MIGRATION table are more detailed.
Type_farmaland	Percentage of data completeness too low.
Specie_orchards	Percentage of data completeness too low.
Env_other	Percentage of data completeness too low.
Queen_import	Irrelevant.
Queen_import_or	Number of records too low.
Quenn_import_or2	Number of records too low.
Harbor	Irrelevant.
Airport	Irrelevant.

BEEKEEPER table

INCL	
Org_member	Variable included.
Continue	Variable included.
Breed	Variable included.

There was no variable classified in blue or red (from the criterion #1) and **TO BE TRANSFORMED** in the BEEKEEPER table.

NOT INCL	
Surname	Irrelevant.
Postal adress	Irrelevant.
City	Irrelevant.
Tel	Irrelevant.
Fax	Irrelevant.
E-mail	Irrelevant.
Follower	Percentage of data completeness too low.
LAU	Irrelevant.
Lat	Irrelevant.
Long	Irrelevant.
Other risk	Irrelevant.

COLONY table

There was no variable classified in green or yellow (from the criterion #1) and **INCLUDED** in the COLONY table.

There was no variable classified in green or yellow (from the criterion #1) and **TO BE TRANSFORMED** in the COLONY table.

NOT INCLUDED	
Field_ID	Irrelevant.
Strength_colonie	Percentage of data completeness too low.
Reason	Redundant information with "Random" from the VISIT table.

COLONY table

There was no variable classified in blue or red (from the criterion #1) and **INCLUDED** COLONY table.

There was no variable classified in blue or red (from the criterion #1) and **TO BE TRANSFORMED** in the COLONY table.

There was no variable classified in blue or red (from the citerion #1) and **NOT INCLU** COLONY table.

DISEASE table

There was no variable classified in green or yellow (from the criterion #1) and **INCLUDED** in the DISEASE table.

TO BE TRANSFORMED	
Suspected	Paired with the STRENGTH table to calculate the varroosis prevalence.
Date	Used to identify data from autum, spring and summer.

There was no variable classified in green or yellow (from the criterion #1) and **NOT INCLUDED** in the DISEASE table.

DISEASE table

There was no variable classified in blue or red (from the criterion #1) and **INCLUDED** DISEASE table.

There was no variable classified in blue or red (from the criterion #1) and **TO BE TRANSFORMED** in the DISEASE table.

NOT INCL	
Remark	Percentage of data completeness too low.

HEALTH table

There was no variable classified in green or yellow (from the criterion #1) and **INCLUDED** in the HEALTH table.

There was no variable classified in green or yellow (from the criterion #1) and **TO BE TRANSFORMED** in the HEALTH table.

There was no variable classified in green or yellow (from the criterion #1) and **NOT INCLUDED** in the HEALTH table.

HEALTH table

INCL	
Type_event	Variable included.

There was no variable classified in blue or red (from the criterion #1) and **TO BE TRANSFORMED** in the HEALTH table.

NOT INCL	
Other	Percentage of data completeness too low.
Disease_event	Percentage of data completeness too low.
Other_D	Percentage of data completeness too low.
Percentage affected	Percentage of data completeness too low.
Lab	Percentage of data completeness too low.
Conclusion	Percentage of data completeness too low.
Other_C	Percentage of data completeness too low.
Treatment	Percentage of data completeness too low.

MANAGEMENT table

INCLUDED	
Management	Variable included.
Swarm_bought	Variable included.
Swarm_produced	Variable included.
Queen_bought	Variable included.
Queen_produced	Variable included.

TO BE TRANSFORMED	
Date_action	Used to identify data from the first year or the second year of EPILOBEE.

NOT INCLUDED	
Colonie_divided	Percentage of data completeness too low.
Colonie_naturally	Percentage of data completeness too low.
Colonie_merged	Percentage of data completeness too low.

MIGRATION table

There was no variable classified in green or yellow (from the criterion #1) and **INCLUDED** in the MIGRATION table.

There was no variable classified in green or yellow (from the criterion #1) and **TO BE TRANSFORMED** in the MIGRATION table.

There was no variable classified in green or yellow (from the criterion #1) and **NOT INCLUDED** in the MIGRATION table.

MANAGEMENT table

There was no variable classified in blue or red (from the criterion #1) and **INCLUDE** MANAGEMENT table.

There was no variable classified in blue or red (from the criterion #1) and **TO BE TRANSFORMED** in the MANAGEMENT table.

NOT INC	
Swarm_or	Percentage of data completeness too low.
Queen_or	Percentage of data completeness too low.

MIGRATION table

INC	
Midseason_Target	Variable included.

TO BE TRANSF	
Start	Used to identify migration period (seasonal - before winter - post wint
End	Used to identify migration period (seasonal - before winter - post wint

NOT INC	
Place 1	Irrelevant.
Place 2	Irrelevant.
Place 3	Irrelevant.
Other	Percentage of data completeness too low.
Colonie	Percentage of data completeness too low.

RESULTS table

There was no variable classified in green or yellow (from the criterion #1) and **INCLUDED** in the RESULTS table.

TO BE TRANSFORMED	
Analysis	Used to calculate disease prevalence.
Technique	Used to calculate disease prevalence.
Result	Used to calculate disease prevalence.
Date	Used to identify data from autum, spring and summer.

NOT INCLUDED	
Apiary	Irrelevant.
Lab_ID	Irrelevant.
Number_varroa	Not needed for the calculation of the disease prevalence.
Number_nosema	Not needed for the calculation of the disease prevalence.

RESULTS table

There was no variable classified in blue or red (from the criterion #1) and **INCLUDED** RESULTS table.

There was no variable classified in blue or red (from the criterion #1) and **TO BE TRANSFORMED** in the RESULTS table.

NOT INCL	
Comment	Percentage of data completeness too low.

SAMPLE table

There was no variable classified in green or yellow (from the criterion #1) and **INCLUDED** in the SAMPLE table.

TO BE TRANSFORMED	
Reason	Used to calculate disease prevalence.
Nature	Used to calculate disease prevalence.
DateV	Used to identify data from autum, spring and summer.

NOT INCLUDED	
Field_ID	Irrelevant.

SAMPLE table

There was no variable classified in blue or red (from the criterion #1) and **INCLUDED** SAMPLE table.

There was no variable classified in blue or red (from the criterion #1) and **TO BE TRANSFORMED** in the SAMPLE table.

There was no variable classified in blue or red (from the criterion #1) and **NOT INCLU** SAMPLE table.

STRENGTH table

There was no variable classified in green or yellow (from the criterion #1) and **INCLUDED** in the STRENGTH table.

TO BE TRANSFORMED	
Date	Used to identify data from autum, spring and summer.
Varroosis	Paired with the DISEASE table to calculate the varroosis prevalence.

NOT INCLUDED	
Dead	Redundant information with "Dead_v1_v2" / "Dead_v2_v3" from the VISIT table.
Force	Incomplete data.
Field_ID	Irrelevant.
Future	Irrelevant.
Type	Redundant information with "Reason" from the COLONY table.

STRENGTH table

There was no variable classified in blue or red (from the criterion #1) and **INCLUDED** STRENGTH table.

There was no variable classified in blue or red (from the criterion #1) and **TO BE TRANSFORMED** in the STRENGTH table.

There was no variable classified in blue or red (from the criterion #1) and **NOT INCLU** STRENGTH table.

SYMPTOMS table

There was no variable classified in green or yellow (from the criterion #1) and **INCLUDED** in the SYMPTOMS table.

TO BE TRANSFORMED	
Symptom[1]	Used for a descriptive analysis, but not published in this report.
Date	Used to identify data from autum, spring and summer.

[1] This variable has too much modalities and to group them is irrelevant.

There was no variable classified in green or yellow (from the criterion #1) and **NOT INCLUDED** in the SYMPTOMS table.

SYMPTOMS table

There was no variable classified in blue or red (from the criterion #1) and **INCLUD** SYMPTOMS table.

There was no variable classified in blue or red (from the criterion #1) and **TO BE TRANSFORMED** in the SYMPTOMS table.

NOT INC	
Remark	Percentage of data completeness too low.

TREATMENT table

There was no variable classified in green or yellow (from the criterion #1) and **INCLUDED** in the TREATMENT table.

There was no variable classified in green or yellow (from the criterion #1) and **TO BE TRANSFORMED** in the TREATMENT table.

NOT INCLUDED	
Name_treat	To be discussed with the member states and not ready for July 2015.
Date_treat	Used to identify data from the first year or the second year of EPILOBEE, but not ready for July 2015.
Frequence	Percentage of data completeness too low.
Treatment_correctly	Percentage of data completeness too low.

TREATMENT table

There was no variable classified in blue or red (from the criterion #1) and **INCLUD** TREATMENT table.

There was no variable classified in blue or red (from the criterion #1) and **TO BE TRANSFORMED** in the TREATMENT table.

NOT INC	
Name_treat	To be discussed with the member states and not ready for July 2015
Posology	Percentage of data completeness too low.
Duration	Percentage of data completeness too low.
Remark	Percentage of data completeness too low.

VISIT table

There was no variable classified in green or yellow (from the criterion #1) and **INCLUDED** in the VISIT table.

TO BE TRANSFORMED	
Date	Used to identify data from the first year or the second year of EPILOBEE.
Rank	Used to identify data from autum, spring and summer.
Random	Used to calculate mortality.
Random_v1_rap	Used to calculate mortality.
Alive_v2	Used to calculate mortality.
Dead_v1_v2	Used to calculate mortality.
sold_v1_v2	Used to calculate mortality.
Merged_v1_v2	Used to create a new variable "Merger".
Alive_v3	Used to calculate mortality.
Dead_v2_v3	Used to calculate mortality.
sold_v2_v3	Used to calculate mortality.
Merged_v2_v3	Used to create a new variable "Merger".

NOT INCLUDED	
Inspected	Percentage of data completeness too low.
Divided_v1_v2	Percentage of data completeness too low.
Divided_v2_v3	Percentage of data completeness too low.
Previous_visit	Percentage of data completeness too low.
Moving_apiary	Percentage of data completeness too low.
During_visit	Percentage of data completeness too low.
Visited_apiary	Percentage of data completeness too low.
Farm_general	Percentage of data completeness too low.
Produce_v1_v2	Percentage of data completeness too low.
Produce_v2_v3	Percentage of data completeness too low.

VISIT table

There was no variable classified in blue or red (from the criterion #1) and **INCLUDED** i
table.

There was no variable classified in blue or red (from the criterion #1) and **TO BE TRANSFORMED** in the VISIT table.

NOT INCL	
Visitor1	Irrelevant.
Visitor2	Irrelevant.
Km	Irrelevant.
Time	Irrelevant.

Appendix F – Specific methodology to process the EPILOBEE data

F1 : Thematics bound with dates

The dates recorded in the database were used in different ways according to the thematic.

Disease prevalence

In the SAMPLE table, the sample date was paired with the visit (e.g. autumn, spring or summer visit). When the SAMPLE and RESULTS tables were merged, the disease prevalence were calculated for autumn, spring or summer visits.

For the statistical analysis taking the **winter mortality** as a response variable, the five explanatory variables *American foulbrood*, *European foulbrood*, *Varroosis*, *Nosemosis* and *Chronic paralysis* referred to the prevalence of these five diseases in a given apiary at the previous visit (i.e. autumn visit = V1).

For the statistical analysis taking the **seasonal mortality** as a response variable, the five explanatory variables *American foulbrood*, *European foulbrood*, *Varroosis*, *Nosemosis* and *Chronic paralysis* referred to the prevalence of these five diseases in a given apiary at the previous visit (i.e. spring visit = V2).

The management of apiaries

A date was reported in the MANAGEMENT table for each event. All records with a date between 1st of January 2012 and 31st of July 2013 were used in the analysis of EPILOBEE first year. All the records with a date between 1st of August 2013 and 31st of July 2014 were used in the analysis of EPILOBEE second year.

Colony migrations

The dates for the beginning and the end of the migration were reported in the MIGRATION table. Three periods of migration were defined as described in Table 23. Only the records from the seasonal migration were sufficiently high in numbers to be kept for the analysis. Records pre and post winter migrations were excluded from the analysis. Consequently, during the rest of the report, the *Target* variable (from the MIGRATION table – see Appendix B) will be renamed *MidSeason_Target*.

For the statistical analysis taking the **winter mortality** as a response variable, the target of the previous seasonal migration (i.e. *MidSeason_Target*) was considered as explanatory variable.

For the statistical analysis taking the **seasonal mortality** as a response variable, due to the fact that the records from before and post winter migrations were not sufficient, no target was studied.

Table 23: The time of the year for colony migration

Period	Migration	Number of records
EPILOBEE first year		
1st April 2012 - 31st August 2012	Seasonal	441
1st September 2012 - 30th November 2012	Before winter	57
1st February 2013 - 31th March 2013	Post winter	25
EPILOBEE second year		
1st April 2013 - 31st August 2013	Seasonal	365
1st September 2013 - 30th November 2013	Before winter	27
1st February 2014 - 31th March 2014	Post winter	2

F2: The workable dataset

For the statistical analysis, all the information had to be expressed at the apiary level which was the epidemiological unit. Therefore, information recorded at the beekeeper level (MANAGEMENT, MIGRATION, HEALTH_EVENTS, VISIT, RESULTS tables) should be reported in the BEEKEEPER_APIARY table.

Below is an example with the *MidSeason_Target* variable recorded in the MIGRATION table. Three types of environment could be targeted for migration (Crops , Wildflowers or "Other"). An example of the information stored for three apiaries (*ID_api*) is given in Table 24. Two apiaries (600 and 602) performed two migrations (*ID_migr*) with different targets.

Table 24: Example for the MIGRATION table

ID_migr	ID_api	MidSeason_Target
01	600	Crops
02	600	Wildflowers
03	601	Crops
04	602	WildFlowers
05	602	Other

The information was stored in a temporary table with specific columns corresponding to the three targets. This table identified each apiary in a unique way. The categories"Yes" or "No" were reported according to the information recorded in the MIGRATION table (Table 25).

Table 25: Example of a temporary table used to store information on targeted migration

ID_api	Crops	Wildflowers	Other
600	Yes	Yes	No
601	Yes	No	No
602	No	Yes	Yes

Following this intermediate step, the information was concatenated (according to the categories) and reported as one new *MidSeason Target* variable added to the BEEKEEPER_APIARY table (Table 26).

Table 26: Example of the BEEKEEPER_APIARY table with the information on targeted migration

ID_api	Country	Age	Coop_treat	Activity	....	....	MidSeason Target
....					....	....	
600	SLOVAKIA	30-45	Yes	Hobby	....	....	Crops + Wildflowers
601	LATVIA	45-65	Yes	Professional	....	....	Crops
602	SPAIN	<30	No	Hobby	....	....	Wildflowers + Others
....					....	....	

The specific case of "no information"

For some apiaries, there was no information in the MIGRATION table (for example apiary 651 in Table 27). In this case, it was impossible to know if the migration of the apiary 651 did not target a specific environment, or if, for unknown reasons this information was not reported in the MIGRATION table. This uncertainty was stored as "No information" in the BEEKEEPER_APIARY table (Table 28).

Table 27: Example of the MIGRATION table with the specific case of "no information"

ID_migr	ID_api	MidSeason Target
01	650	Crops
02	650	Other
03	652	Crops
04	652	WildFlowers
05	653	WildFlowers

Table 28: Example of the BEEKEEPER_APIARY table (specific case of "no information")

ID_api	Country	Age	Coop_treat	Activity	....	....	MidSeason Target
....					....	....	
650	SWEDEN	45-65	Yes	Part-time	....	....	Crops + Other
651	DENMARK	<30	Yes	Professional	....	....	No information
652	BELGIUM	45-65	No	Hobby	....	....	Crops+ Wildflowers
653	ESTONIA	30-45	No	Hobby	....	....	Wildflowers
....					....	....	

Specific case of empty cells

In some cases, the information in *MidSeason_Target* was missing for a given *ID_migr* (for example, apiary 681 in Table 29). The apiary 681 had targeted an environment (this information was recorded in the MIGRATION table). However, given that the environment was not specified, NA was added in the BEEKEEPER table _APIARY (Table 30).

Table 29: Example of the MIGRATION table with the special case of "empty cell"

ID_migr	ID_api	MidSeason_Target
01	680	Crops
02	680	WildFlowers
03	681	
04	682	WildFlowers
05	682	Other

Table 30: Example of the BEEKEEPER_APIARY table (specific case of "empty cell")

ID_api	Country	Age	Coop_treat	Activity	....	....	MidSeason_Target
....					....	....	
680	FINLAND	<30	No	Hobby	....	....	Crops+ Wildflowers
681	GERMANY	45-65	Yes	Professional	....	....	NA
682	LITHUANIA	30-45	No	Hobby	....	....	Wildflowers+Other
....					....	....	

Information from other tables

The information stored in the MIGRATION and MANAGEMENT tables was reported in the BEKEEPER_APIARY table according to the process described in the Tables 24 to 26 and the information stored in the HEALTH_EVENTS and RESULTS tables according to the Tables 24 and 25. From the VISIT table, only the *merged* information was reported in the BEEKEEPER_APIARY table. For a given apiary, if the beekeeper had merged at least one colony once, the category "Yes" was reported in the BEEKEEPER_APIARY table, otherwise "No" was reported.

Appendix G – Distribution of the apiaries for the different variables[29] included in the analysis

G1 : Country

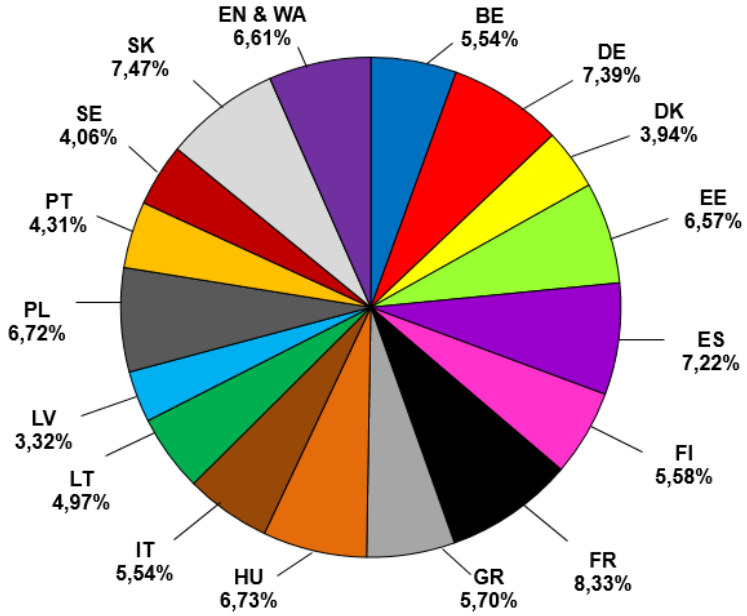


Figure 11: Distribution of the apiaries according to the country, during EPILOBEE *first* year

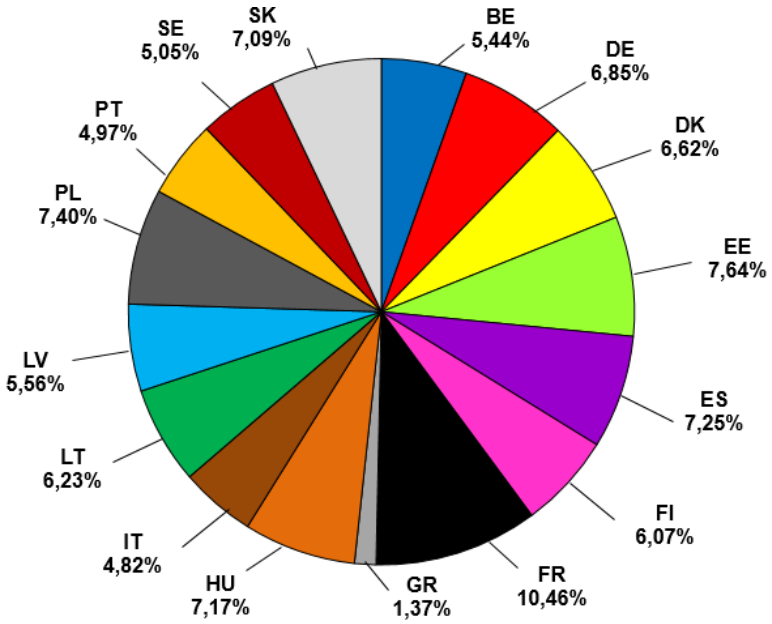


Figure 12: Distribution of the apiaries according to the country, during EPILOBEE *second* year

[29] Variable with at least three categories.

G2 : Beekeeper activity

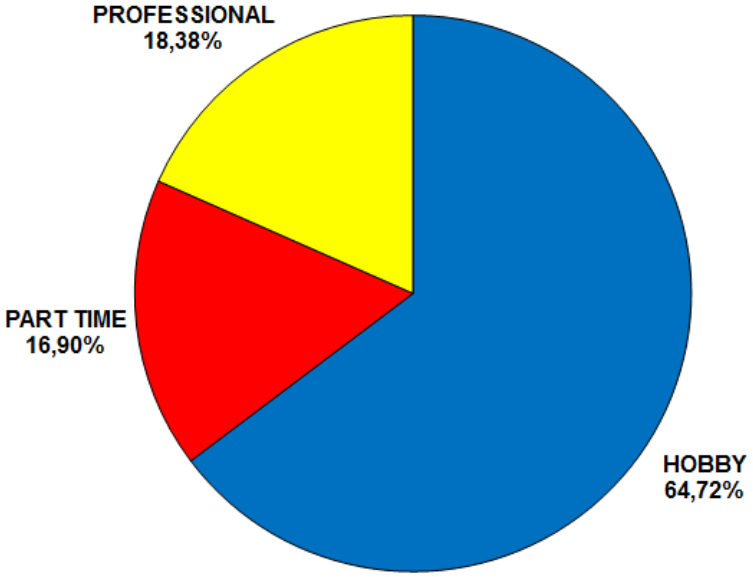


Figure 13: Distribution of the apiaries according to the beekeeper activity, during EPILOBEE *first* year

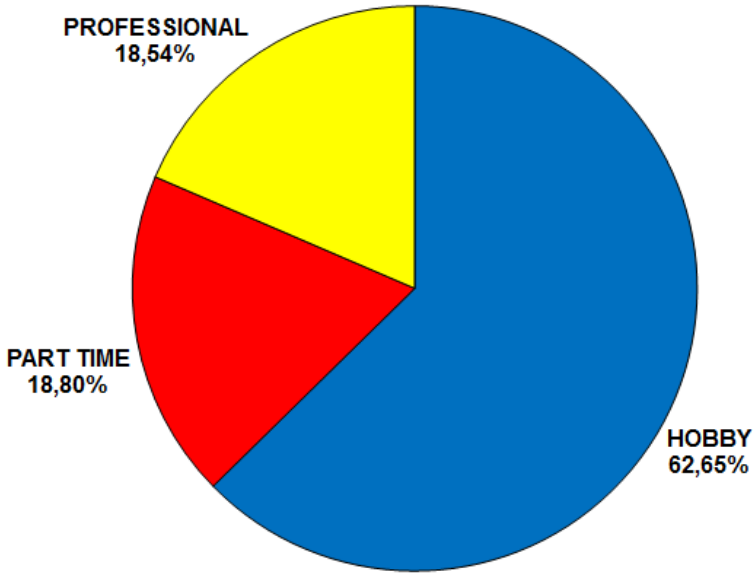


Figure 14: Distribution of the apiaries according to the beekeeper activity, during EPILOBEE *second* year

G3 : Beekeeper age

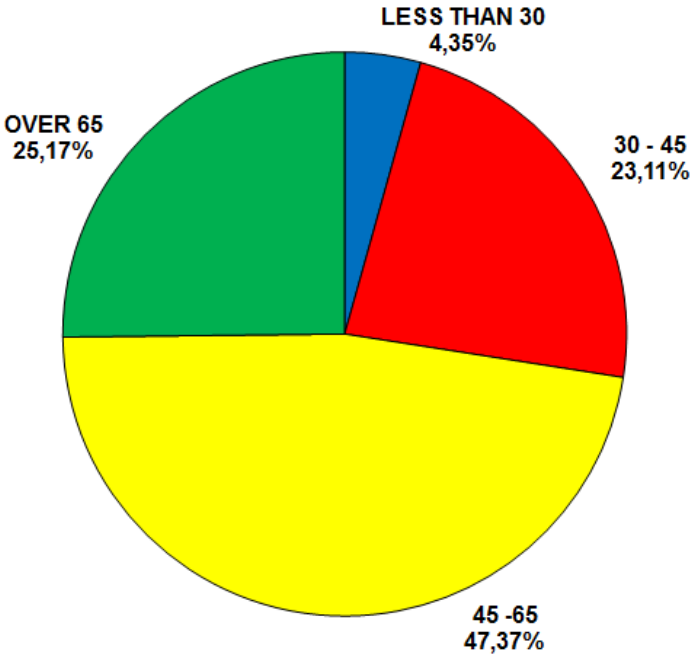


Figure 15: Distribution of the apiaries according to the beekeeper age, during EPILOBEE *first* year

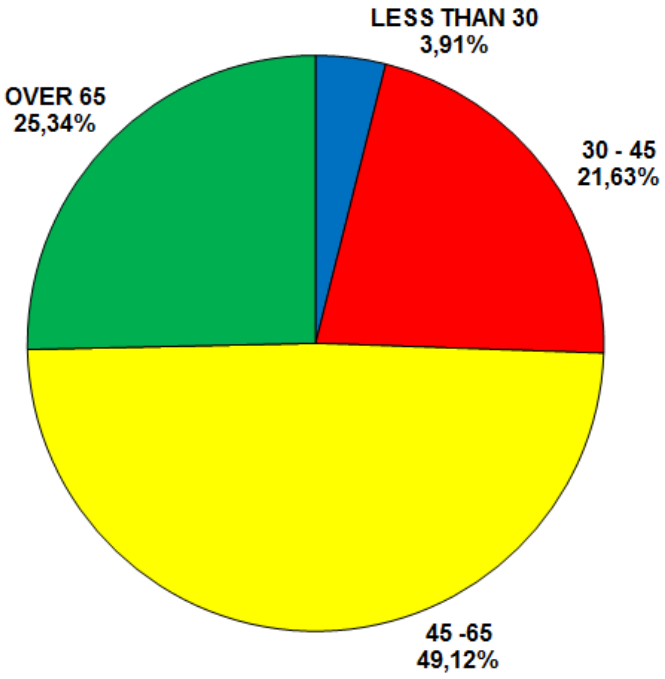


Figure 16: Distribution of the apiaries according to the beekeeper age, during EPILOBEE *second* year

G4 : Beekeeper experience

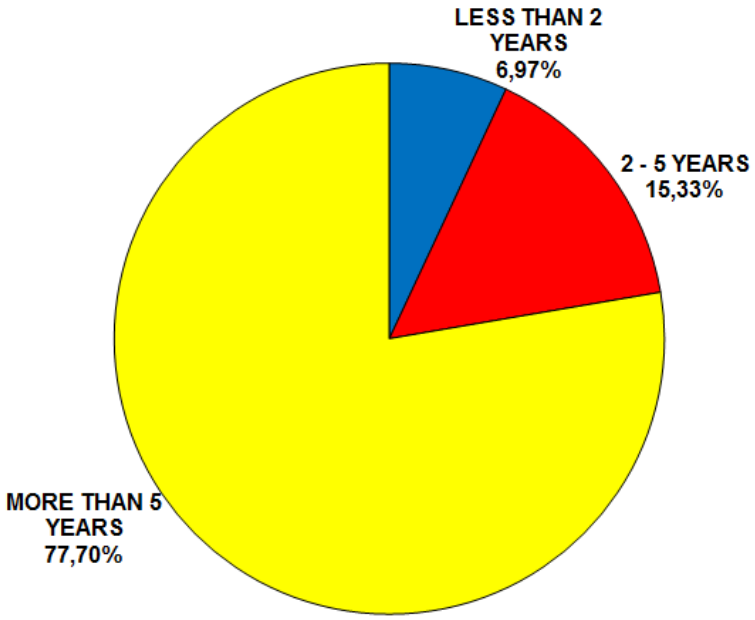


Figure 17: Distribution of the apiaries according to the beekeeper experience, during EPILOBEE *first* year

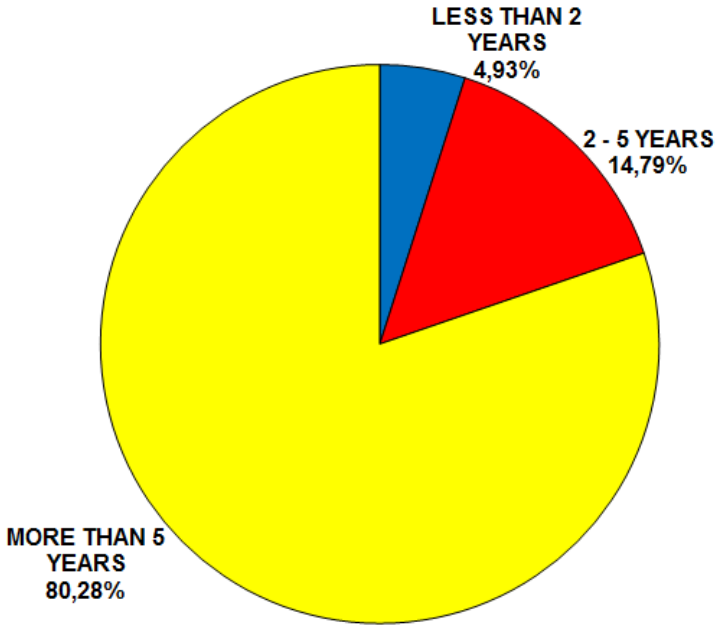


Figure 18: Distribution of the apiaries according to the beekeeper experience, during EPILOBEE *second* year

G5 : Apiary size

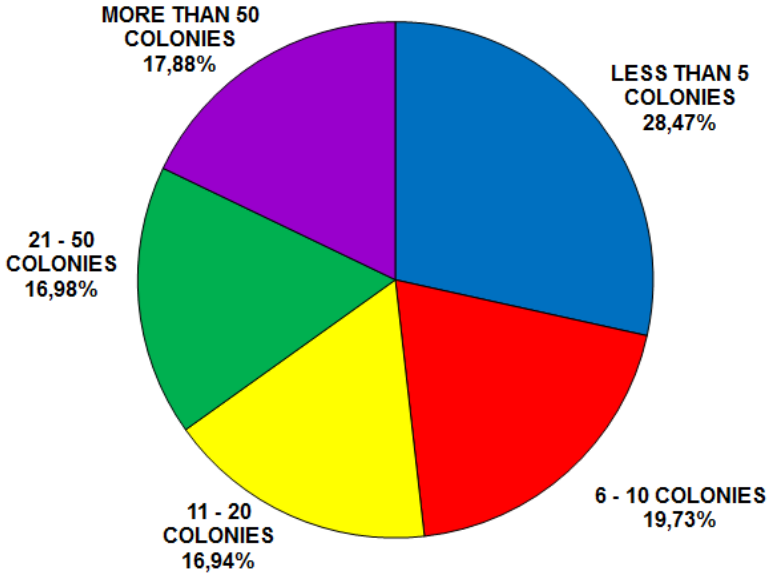


Figure 19: Distribution of the apiaries according to the apiary size during EPILOBEE *first* year

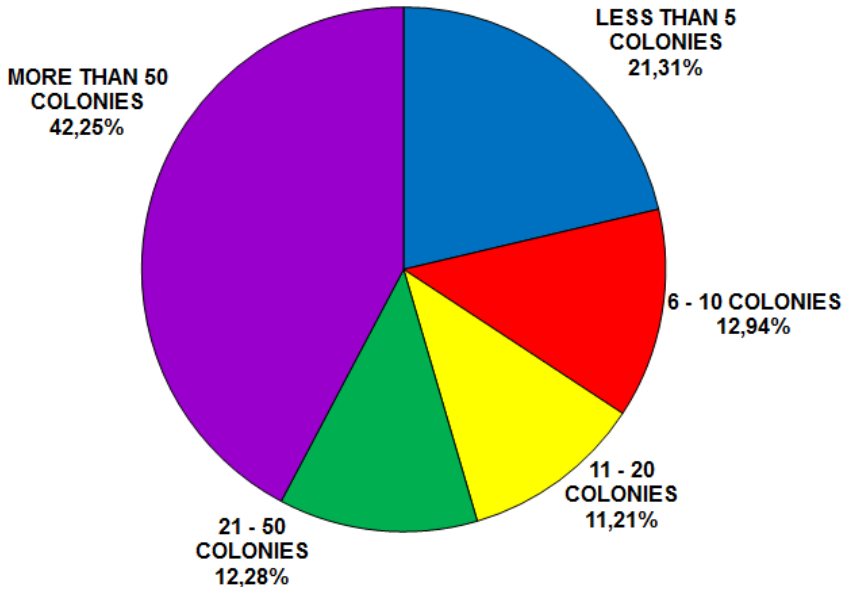


Figure 20: Distribution of the apiaries according to the apiary size during EPILOBEE *second* year

G6 : Size of the operation

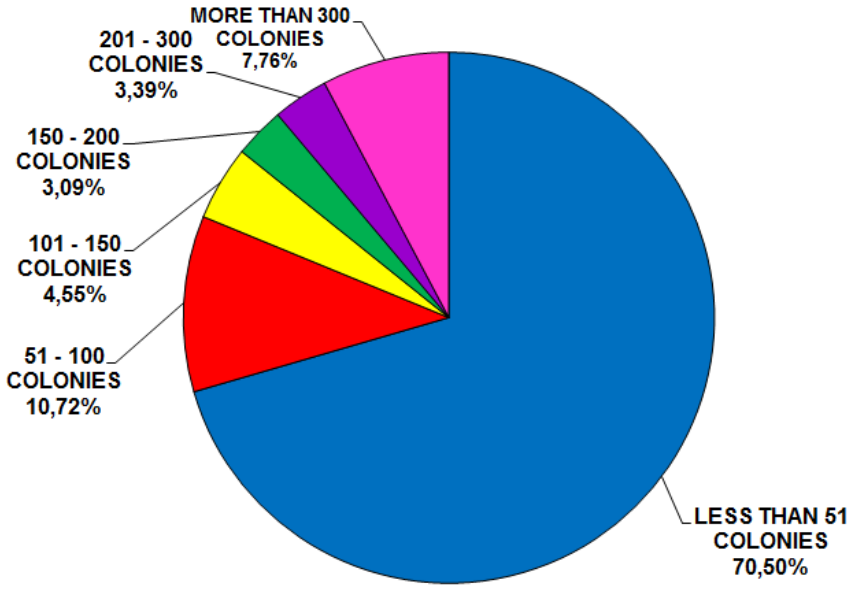


Figure 21: Distribution of the apiaries according to the size of the operation, during EPILOBEE *first* year

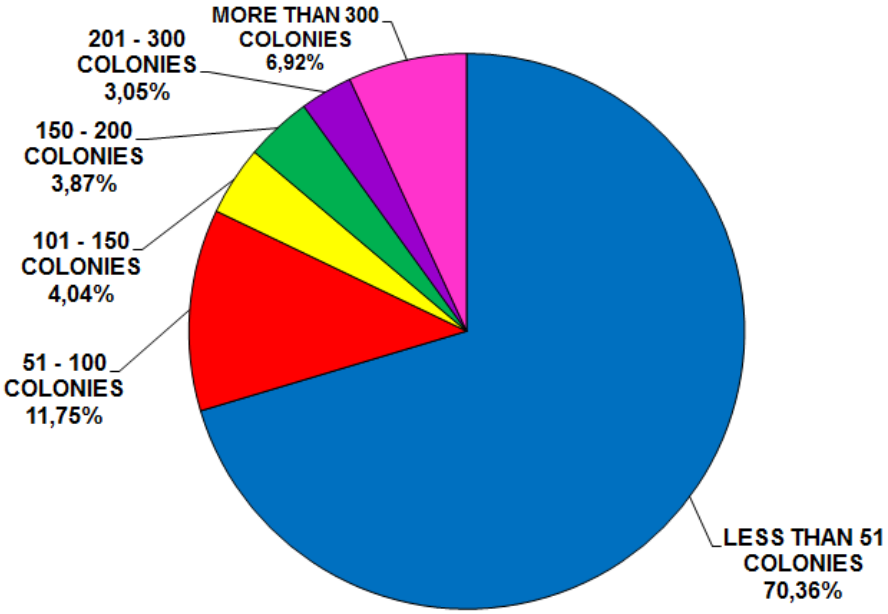


Figure 22: Distribution of the apiaries according to the size of the operation, during EPILOBEE *second* year

G7: Honeybee breed

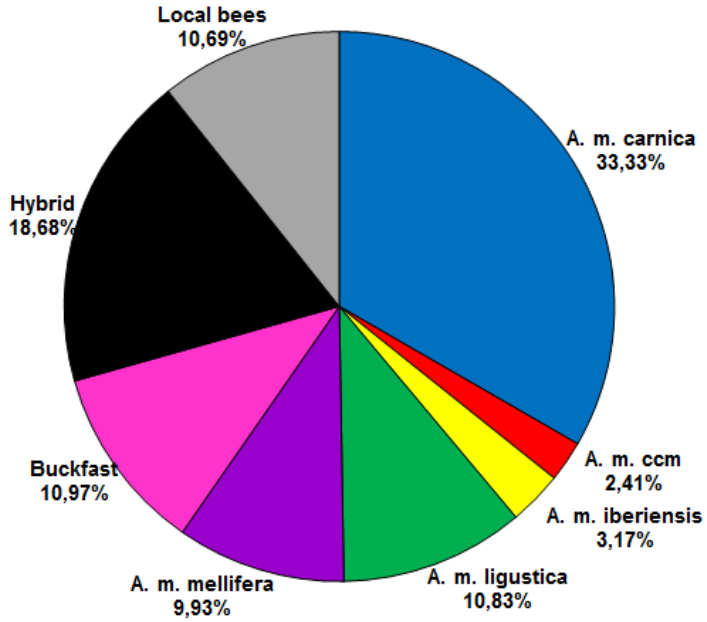


Figure 23: Distribution of the apiaries according to the honeybee breed, during EPILOBEE *first* year

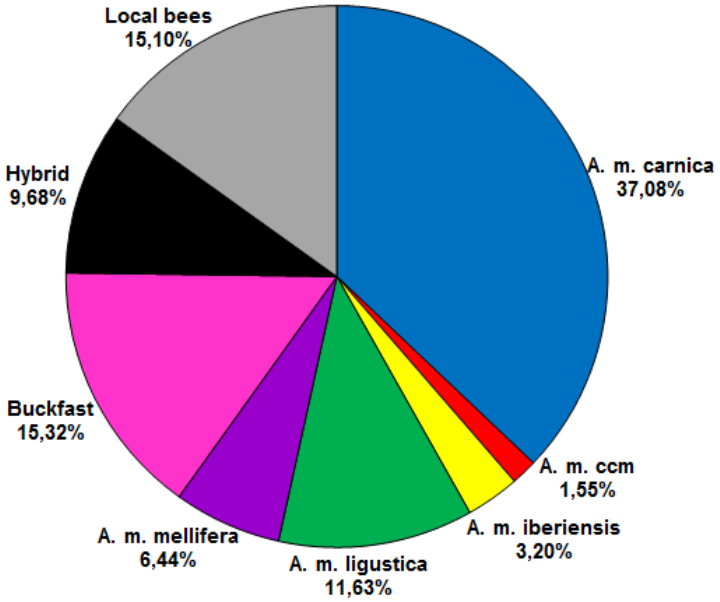


Figure 24: Distribution of the apiaries according to the honeybee breed, during EPILOBEE *second* year

G8: Environmental surrounding of the apiary

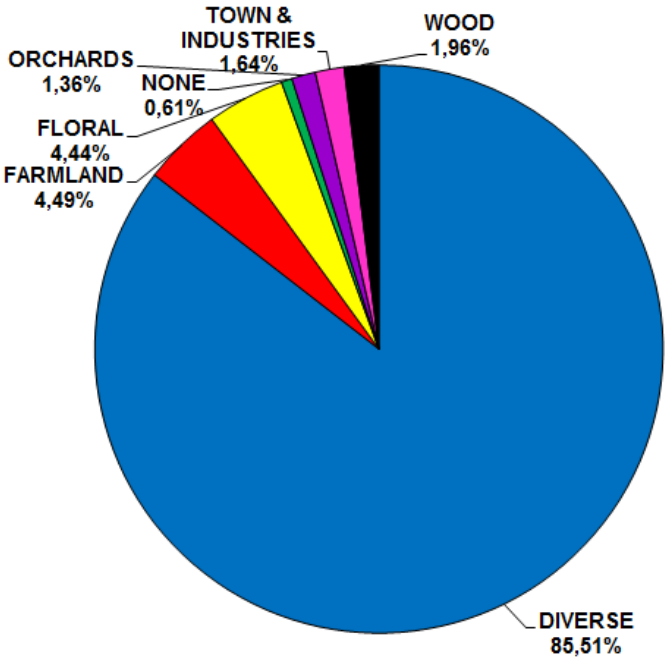


Figure 25: Distribution of the apiaries according to the environmental surrounding of the apiary, during EPILOBEE *first* year

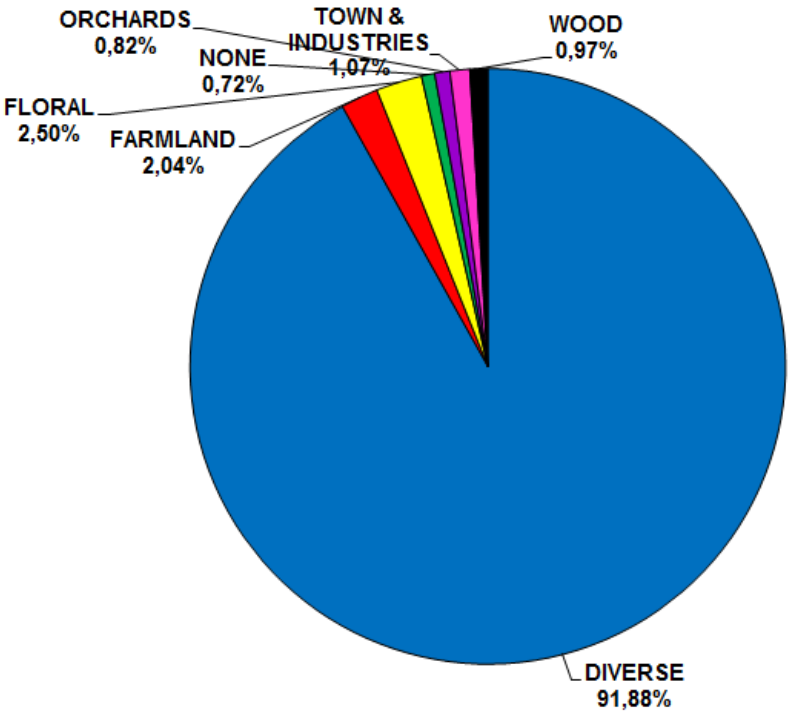


Figure 26: Distribution of the apiaries according to the environmental surrounding ofthe apiary, during EPILOBEE *second* year

G9: Management of the operation

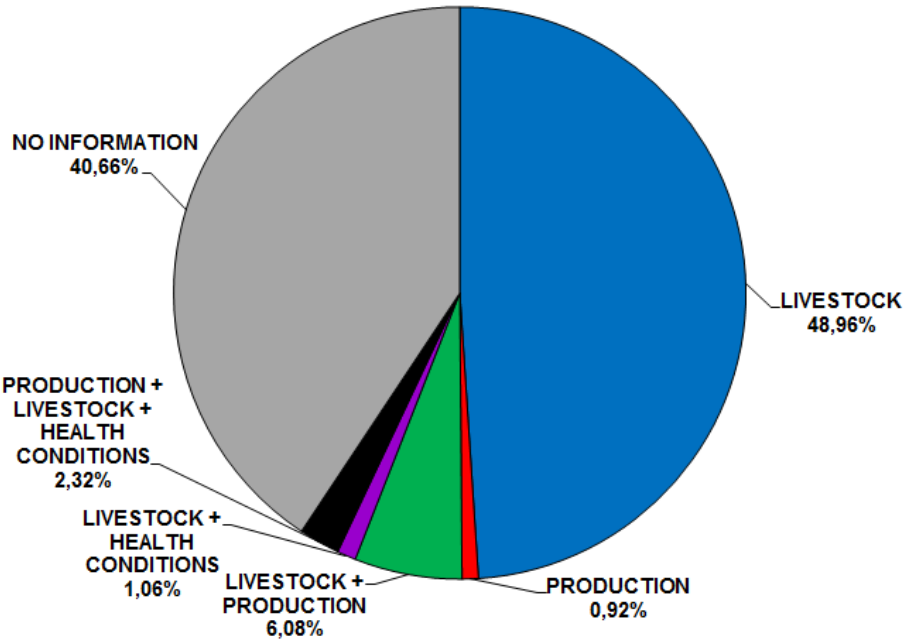


Figure 27: Distribution of the apiaries according to the management of the operation, during EPILOBEE *first* year

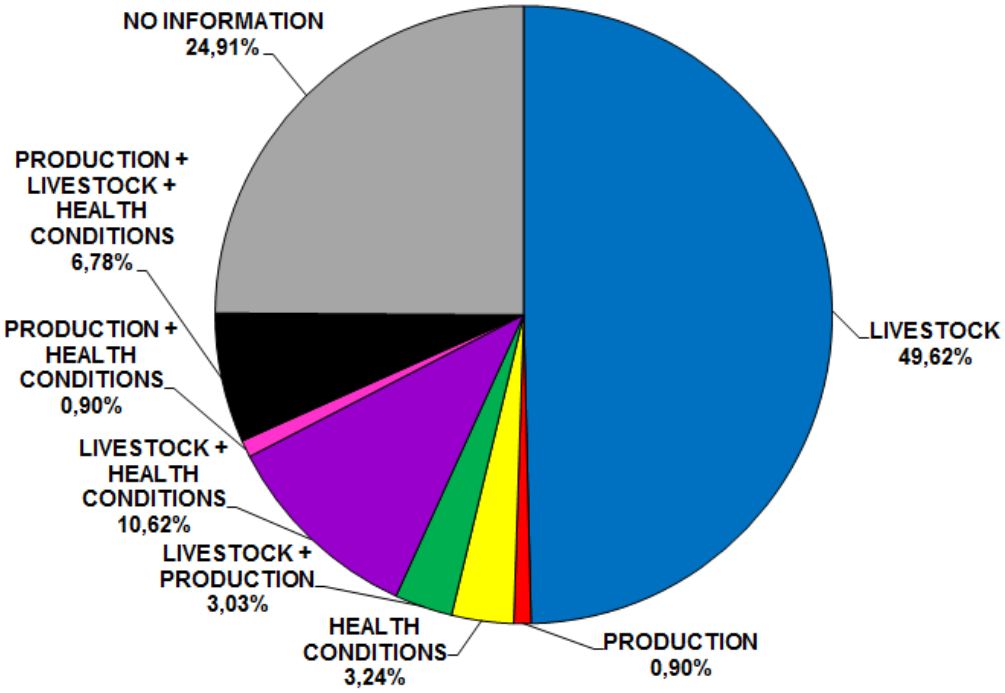


Figure 28: Distribution of the apiaries according to the management of the operation, during EPILOBEE *second* year

G10: Queens bought

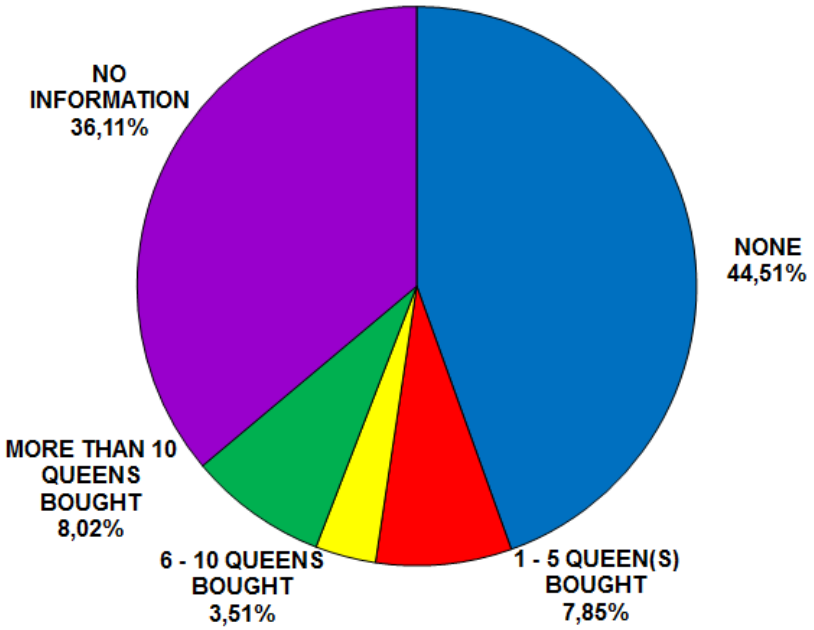


Figure 29: Distribution of the apiaries according to the number of queen bought by the beekeeper, during EPILOBEE *first* year

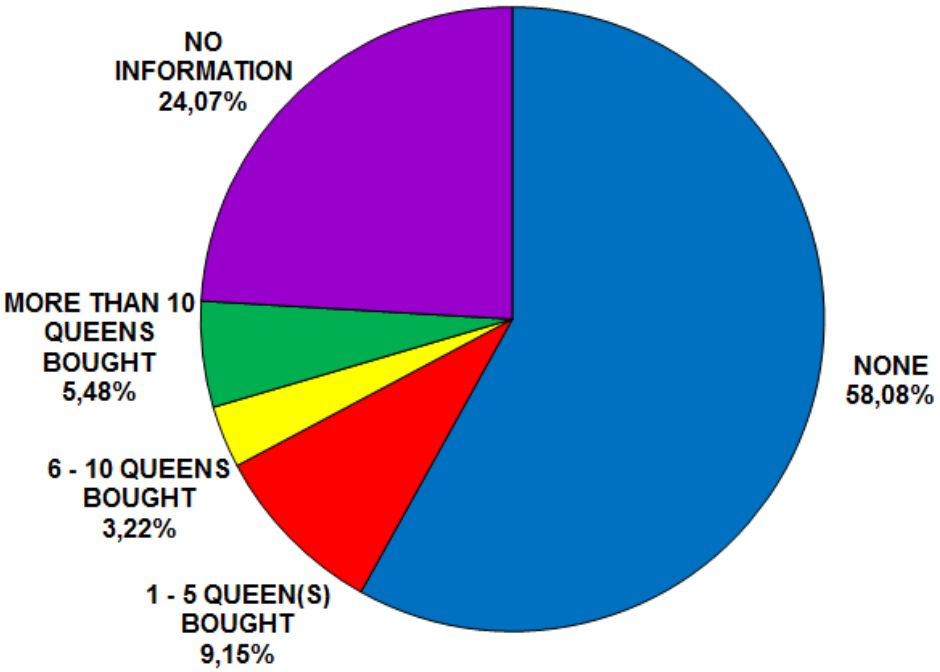


Figure 30: Distribution of the apiaries according to the number of queen bought by the beekeeper, during EPILOBEE *second* year

G11: Queens produced

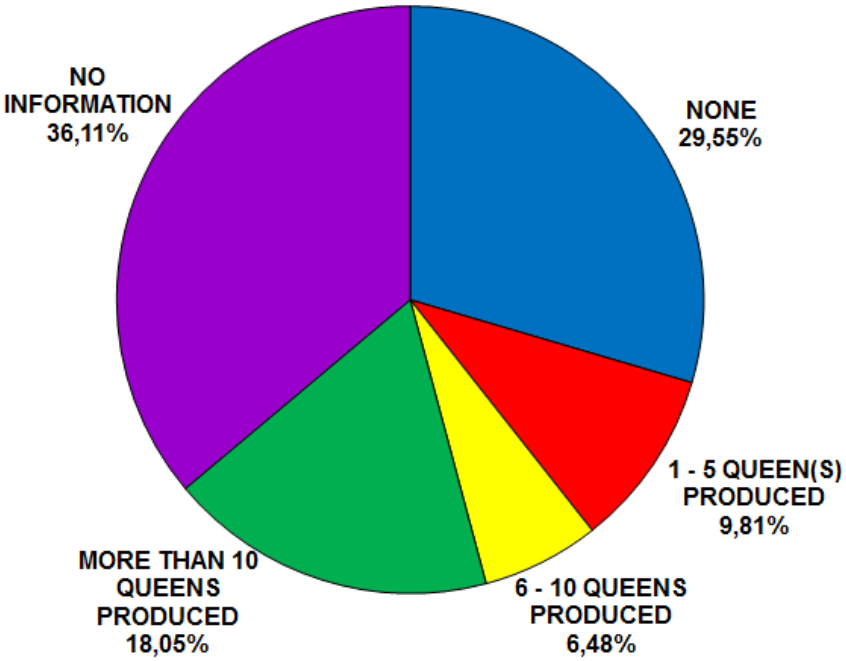


Figure 31: Distribution of the apiaries according to the number of queen produced by the beekeeper, during EPILOBEE *first* year

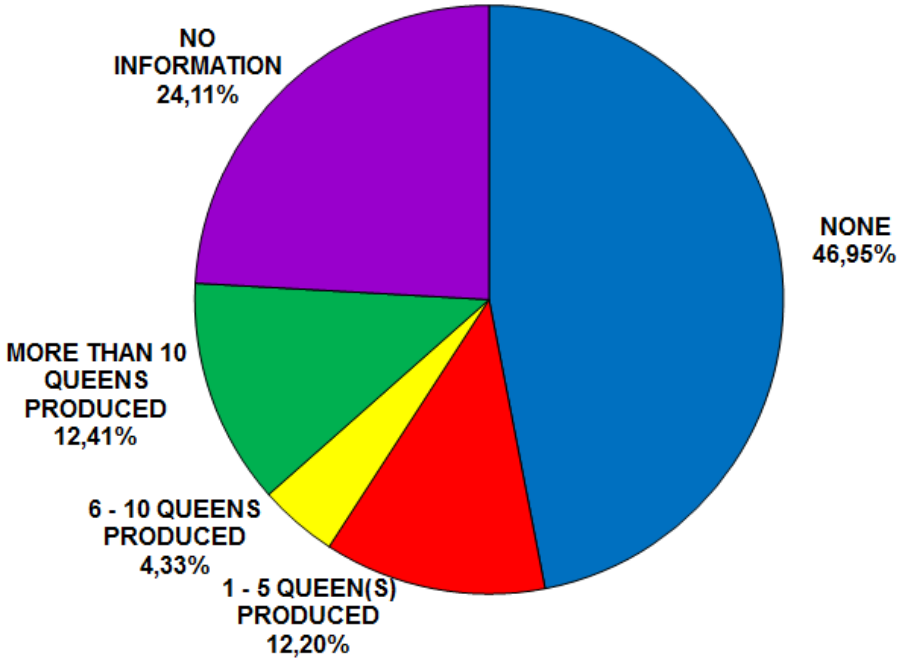


Figure 32: Distribution of the apiaries according to the number of queen produced by the beekeeper, during EPILOBEE *second* year

G12: Swarms bought

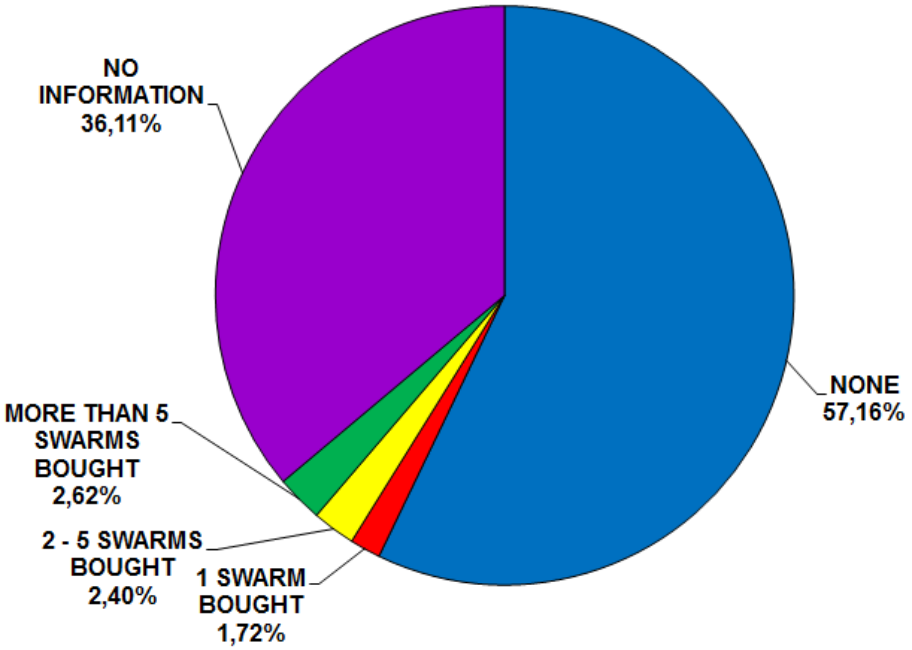


Figure 33: Distribution of the apiaries according to the number of swarm bought by the beekeeper, during EPILOBEE *first* year

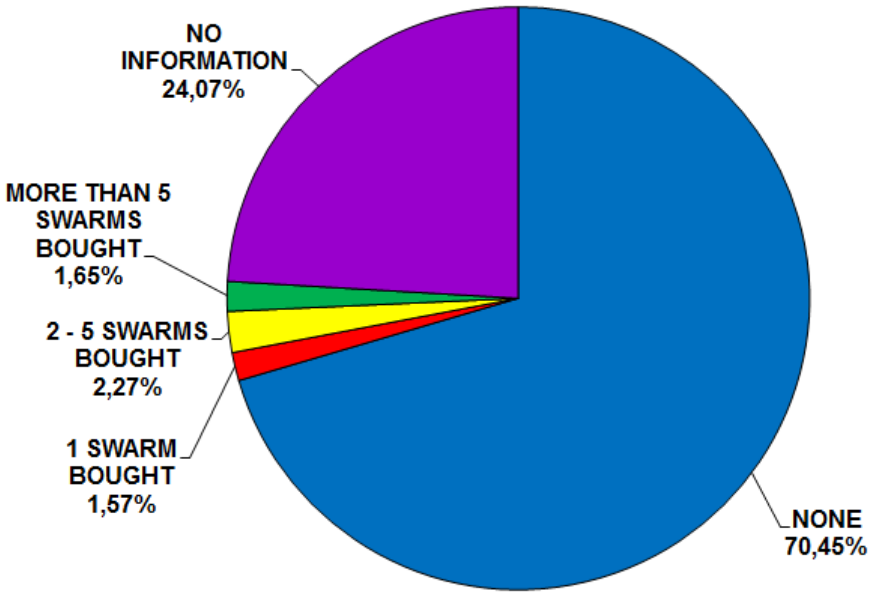


Figure 34: Distribution of the apiaries according to the number of swarm bought by the beekeeper, during EPILOBEE *second* year

G13: Swarms produced

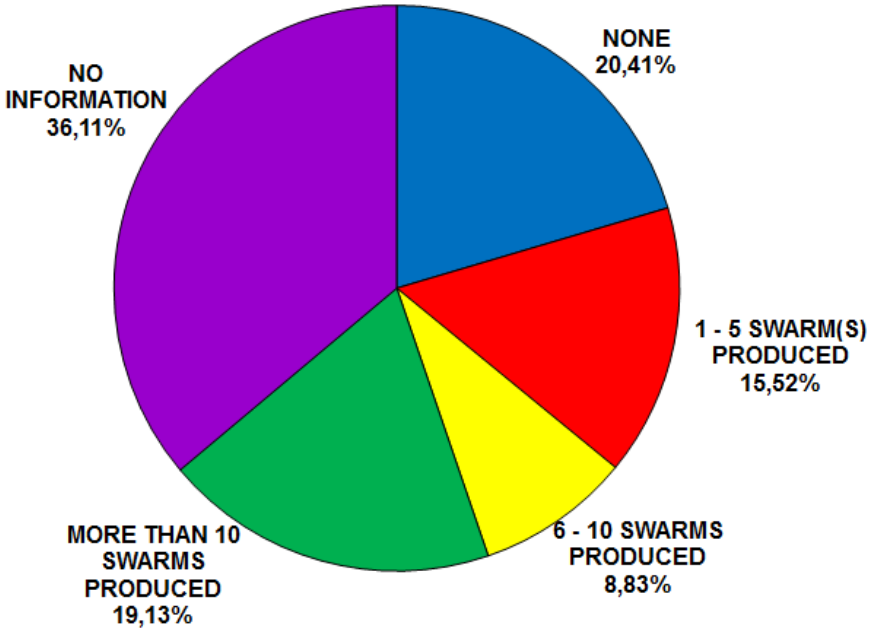


Figure 35: Distribution of the apiaries according to the number of swarm produced by the beekeeper, during EPILOBEE first year

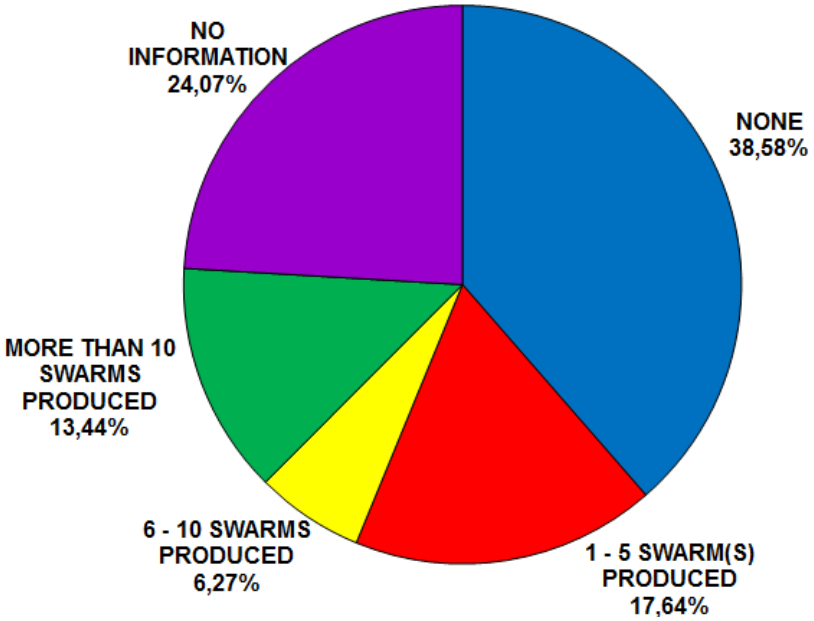


Figure 36: Distribution of the apiaries according to the number of swarm produced by the beekeeper, during EPILOBEE *second* year

G14: Production of the beekeeper

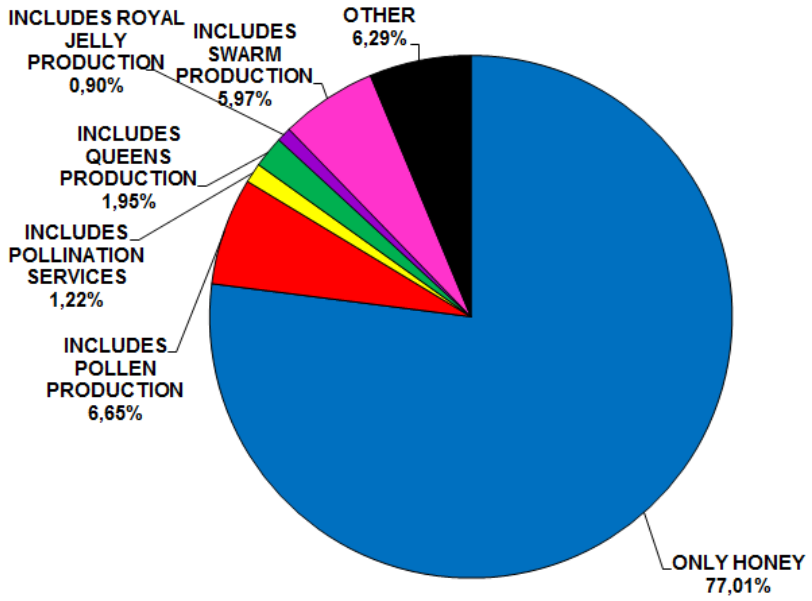


Figure 37: Distribution of the apiaries according to the production of the beekeeper, during EPILOBEE *first* year

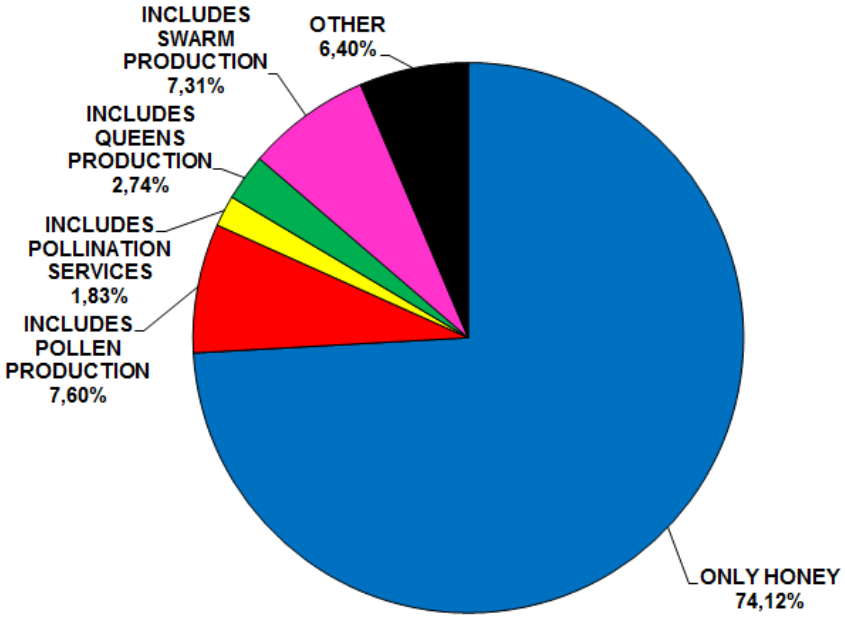


Figure 38: Distribution of the apiaries according to the production of the beekeeper, during EPILOBEE *second* year

G15: Environment targeted during the previous seasonal migration

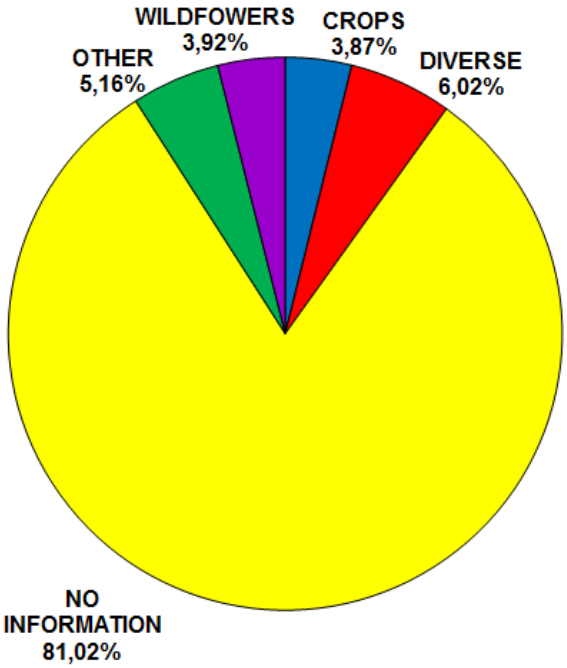


Figure 39: Distribution of the apiaries according to the environement targeted during the previous seasonal migration, during EPILOBEE *first* year

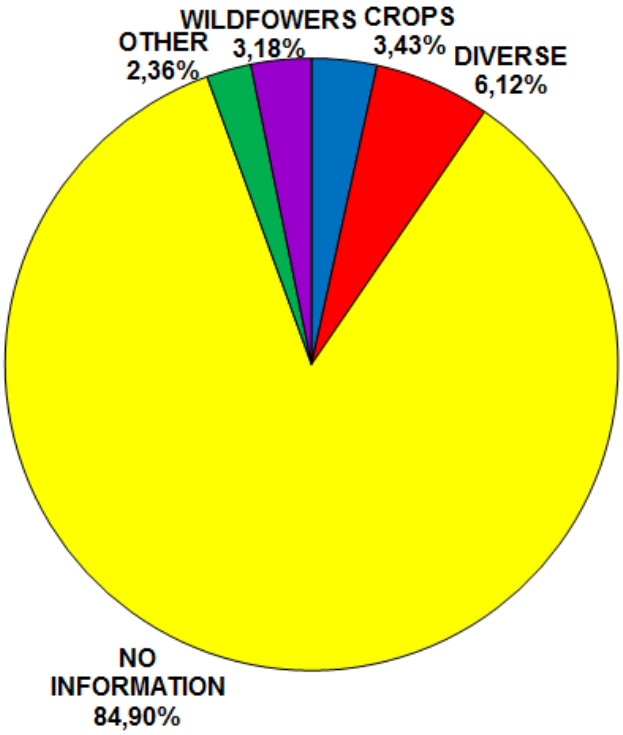


Figure 40: Distribution of the apiaries according to the environement targeted during the previous seasonal migration, during EPILOBEE *second* year

G16: Previous winter mortality

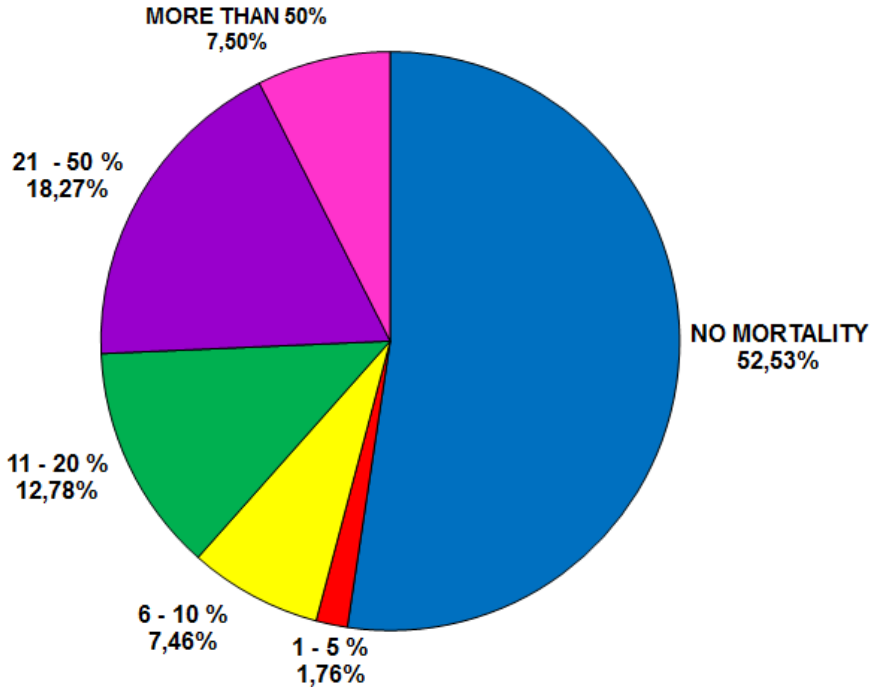


Figure 41: Distribution of the apiaries according to the previous winter mortality, during EPILOBEE *first* year

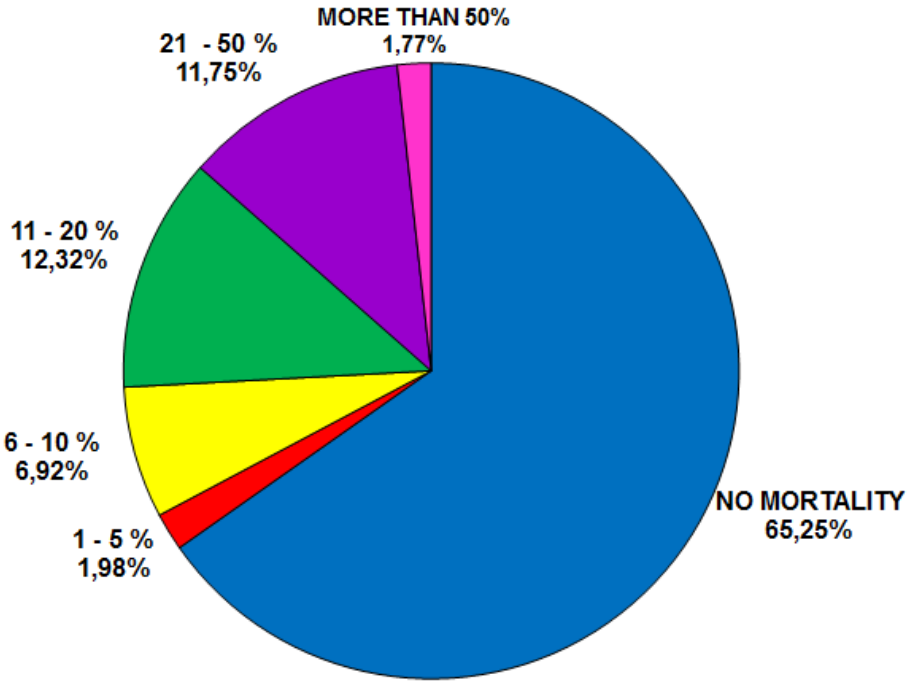


Figure 42: Distribution of the apiaries according to the previous winter mortality, during EPILOBEE *second* year

Appendix H – Study for each year of EPILOBEE: variables with a statisitically significant effect on the winter and seasonal mortalities

H1: Winter mortality

In this appendix, the threshod 0.05 was used.

When the variable had a statistically significant effect on the winter mortality (*i.e.* p-value < 0.05) the cell was **colored in yellow**. When the variable did not have any statistically significant effect on the winter mortality (*i.e.* p-value > 0.05), the cell was **colored in white**.

Variables	EPILOBEE *first* year		EPILOBEE *second* year	
	p-value	decision	p-value	decision
Age	0.03	statistically significant effect	0.36	NSSE
Activity	1×10^{-13}	statistically significant effect	0.04	statistically significant effect
Beekeep_for	0.06	NSSE	0.34	NSSE
Qualif	0.95	NSSE	0.10	NSSE
Training	0.08	NSSE	1×10^{-3}	statistically significant effect
Coop_treat	0.40	NSSE	0.37	NSSE
Bee_population_size	1×10^{-15}	statistically significant effect	0.01	statistically significant effect
Country	1×10^{-41}	statistically significant effect	1×10^{-18}	statistically significant effect
Apiary_Size	1×10^{-20}	statistically significant effect	1×10^{-6}	statistically significant effect
Production	1×10^{-3}	statistically significant effect	1×10^{-3}	statistically significant effect
Apiarist book	1×10^{-4}	statistically significant effect	0.06	NSSE
Org_member	0.08	NSSE	0.12	NSSE
Continue	0.62	NSSE	0.38	NSSE
Breed	1×10^{-6}	statistically significant effect	1×10^{-3}	statistically significant effect
Chronic_Depop	0.06	NSSE	0.07	NSSE
ClinSign_Brood	0.68	NSSE	0.02	statistically significant effect
ClinSign_Honeybees	0.03	statistically significant effect	1×10^{-3}	statistically significant effect
H_rate_ColMortality	1×10^{-19}	statistically significant effect	1×10^{-10}	statistically significant effect
H_rate_HoneyMortality	0.80	NSSE	0.06	NSSE
Other_Event	0.26	NSSE	0.57	NSSE
VarroaMites	0.45	NSSE	0.02	statistically significant effect
QueenProblems	1×10^{-3}	statistically significant effect	1×10^{-3}	statistically significant effect
Management	1×10^{-13}	statistically significant effect	0.02	statistically significant effect
Swarm_bought	1×10^{-18}	statistically significant effect	1×10^{-5}	statistically significant effect
Swarm_produced	1×10^{-14}	statistically significant effect	0.20	NSSE
Queen_bought	1×10^{-15}	statistically significant effect	0.25	NSSE
Queen_produced	1×10^{-17}	statistically significant effect	0.04	statistically significant effect
MidSeason_Target	1×10^{-3}	statistically significant effect	0.14	NSSE
Environment	0.04	statistically significant effect	0.21	NSSE
AmericanFoulbroodV1	1×10^{-6}	statistically significant effect	1×10^{-10}	statistically significant effect
AmericanFoulbroodV2	-	-	-	-
EuropeanFoulbroodV1	0.56	NSSE	0.55	NSSE
EuropeanFoulbroodV2	-	-	-	-
VarroosisV1	1×10^{-7}	statistically significant effect	0.24	NSSE
VarroosisV2	-	-	-	-
NosemosisV1	0.24	NSSE	0.81	NSSE
NosemosisV2	-	-	-	-
ChronicParalysisV1	0.78	NSSE	0.81	NSSE
ChronicParalysisV2	-	-	-	-
Migration	1×10^{-5}	statistically significant effect	0.09	NSSE
Merger	0.02	statistically significant effect	1×10^{-6}	statistically significant effect
Winter_mortality_class	-	-	-	-
First_Second	-	-	0.88	NSSE

NSSE: non statistically significant effect

H2: Seasonal mortality

In this appendix, the threshod 0.05 was used.

When the variable had a statistically significant effect on the seasonal mortality (*i.e.* p-value < 0.05) the cell was **colored in yellow**. When the variable did not have any statistically significant effect on the seasonal mortality (*i.e.* p-value > 0.05), the cell was **colored in white**.

Variables	EPILOBEE *first* year		EPILOBEE *second* year	
	p-value	decision	p-value	decision
Age	0.20	NSSE	0.50	NSSE
Activity	0.26	NSSE	0.76	NSSE
Beekeep_for	0.84	NSSE	0.95	NSSE
Qualif	0.81	NSSE	0.57	NSSE
Training	0.09	NSSE	0.09	NSSE
Coop_treat	1×10^{-3}	statistically significant effect	0.16	NSSE
Bee_population_size	0.08	NSSE	0.04	statistically significant effect
Country	1×10^{-17}	statistically significant effect	1×10^{-27}	statistically significant effect
Apiary_Size	0.19	NSSE	1×10^{-7}	statistically significant effect
Production	0.65	NSSE	0.06	NSSE
Apiarist book	0.40	NSSE	0.06	NSSE
Org_member	0.93	NSSE	0.33	NSSE
Continue	0.47	NSSE	0.42	NSSE
Breed	1×10^{-3}	statistically significant effect	1×10^{-4}	statistically significant effect
Chronic_Depop	1×10^{-3}	statistically significant effect	0.03	statistically significant effect
ClinSign_Brood	1×10^{-6}	statistically significant effect	1×10^{-6}	statistically significant effect
ClinSign_Honeybees	1×10^{-3}	statistically significant effect	0.03	statistically significant effect
H_rate_ColMortality	1×10^{-6}	statistically significant effect	1×10^{-8}	statistically significant effect
H_rate_HoneyMortality	1×10^{-5}	statistically significant effect	1×10^{-3}	statistically significant effect
Other_Event	0.06	NSSE	0.09	NSSE
VarroaMites	0.62	NSSE	0.63	NSSE
QueenProblems	1×10^{-5}	statistically significant effect	1×10^{-6}	statistically significant effect
Management	1×10^{-4}	statistically significant effect	0.01	statistically significant effect
Swarm_bought	1×10^{-3}	statistically significant effect	0.04	statistically significant effect
Swarm_produced	1×10^{-4}	statistically significant effect	0.93	NSSE
Queen_bought	1×10^{-4}	statistically significant effect	0.10	NSSE
Queen_produced	1×10^{-4}	statistically significant effect	0.01	statistically significant effect
MidSeason_Target	-	-	-	-
Environment	0.82	NSSE	0.11	NSSE
AmericanFoulbroodV1	-	-	-	-
AmericanFoulbroodV2	1×10^{-4}	statistically significant effect	0.02	statistically significant effect
EuropeanFoulbroodV1	-	-	-	-
EuropeanFoulbroodV2	1×10^{-5}	statistically significant effect	1×10^{-3}	statistically significant effect
VarroosisV1	-	-	-	-
VarroosisV2	0.14	NSSE	0.02	statistically significant effect
NosemosisV1	-	-	-	-
NosemosisV2	0.50	NSSE	0.86	NSSE
ChronicParalysisV1	-	-	-	-
ChronicParalysisV2	0.51	NSSE	0.86	NSSE
Migration	0.42	NSSE	0.02	statistically significant effect
Merger	1×10^{-3}	statistically significant effect	1×10^{-4}	statistically significant effect
Winter_mortality_class	1×10^{-5}	statistically significant effect	1×10^{-9}	statistically significant effect
First_Second	-	-	0.62	NSSE

NSSE: non statistically significant effect

Appendix I – Study for each year of EPILOBEE: effect of the different variables[30] included in the analysis, on the winter and seasonal mortalities

I1: Country

Please refer to 3.1.2. Study for each year of EPILOBEE : main results

I2: Beekeeper activity

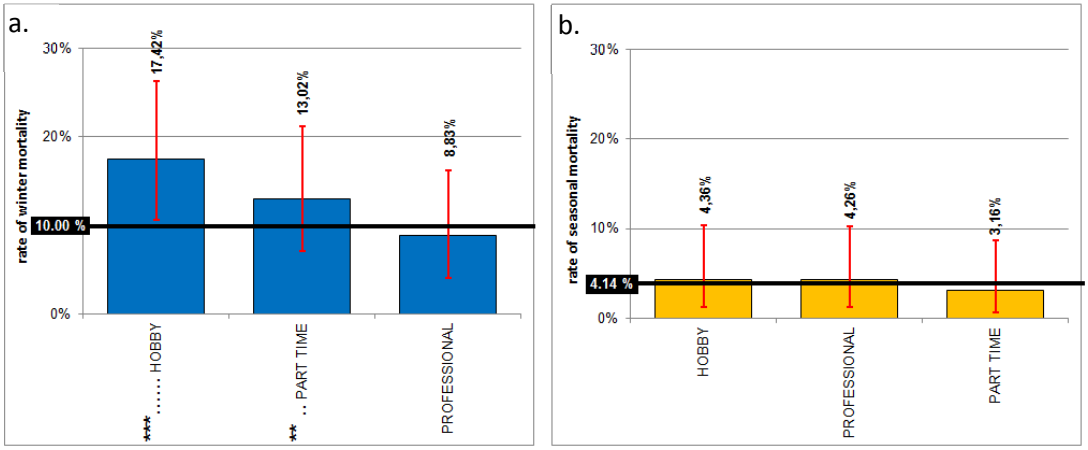


Figure 43: Effect of the variable *Activity*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.14 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

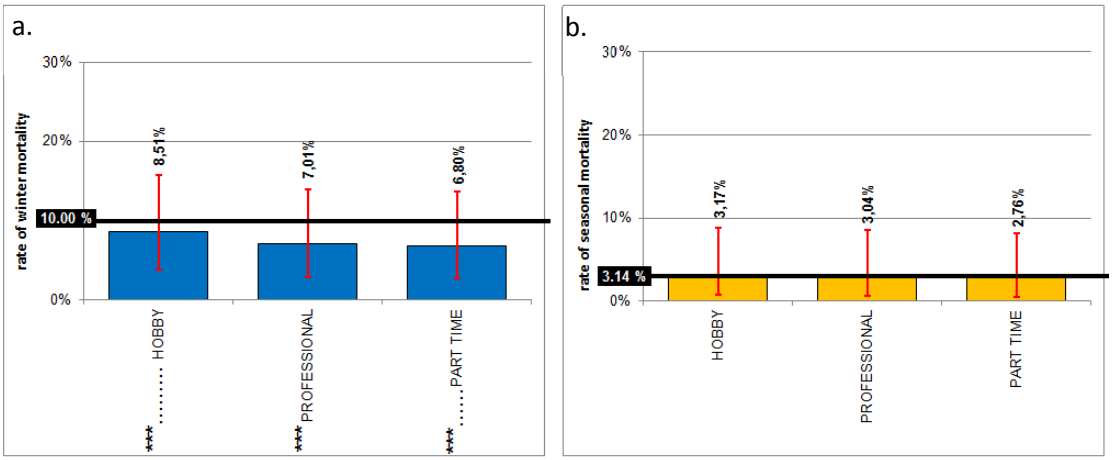


Figure 44: Effect of the variable *Activity*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.14 %) for the seasonal mortality (b) during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

[30] Variable with at least three categories.

I3: Beekeeper age

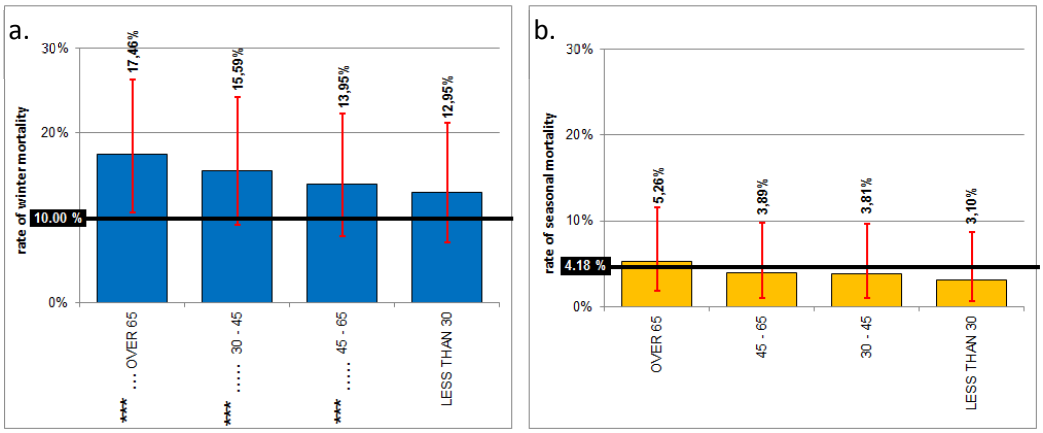


Figure 45: Effect of the variable*Age*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.18 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

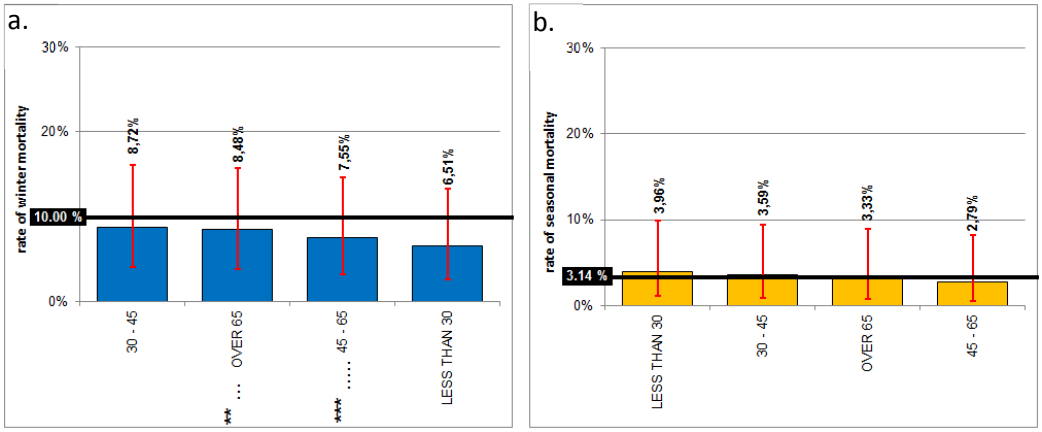


Figure 46: Effect of the variable*Age*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (3.14 %) for the seasonal mortality (b) during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

I4: Beekeeper experience

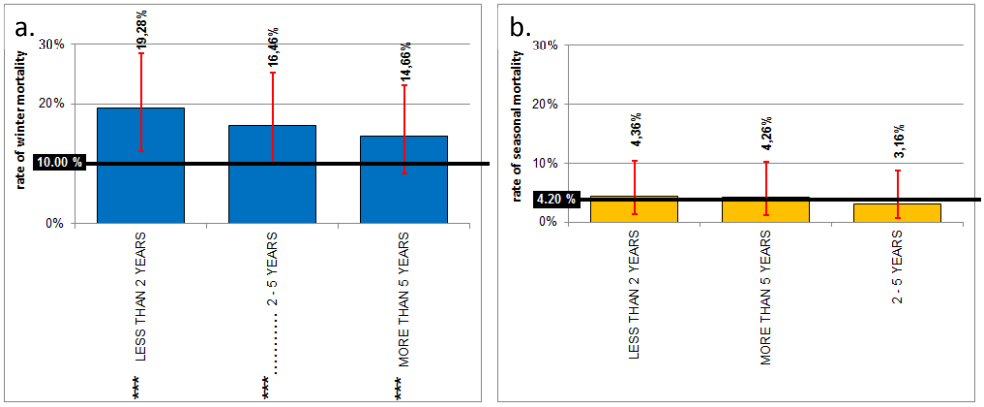


Figure 47: Effect of the variable *Beekeep_for*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.20 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

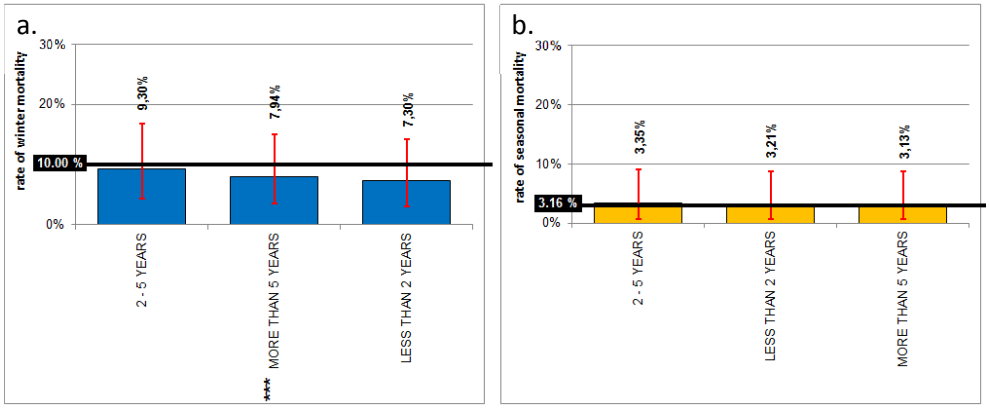


Figure 48: Effect of the variable *Beekeep_for*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (3.16 %) for the seasonal mortality (b) during EPILOBEE second year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

I5: Size of the apiary

a. b.

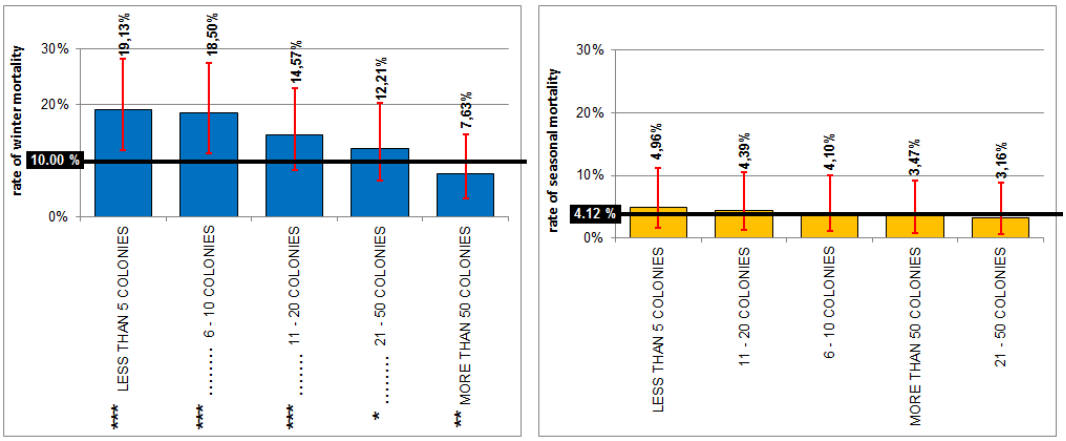


Figure 49: Effect of the variable*Apiary_size*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.12 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

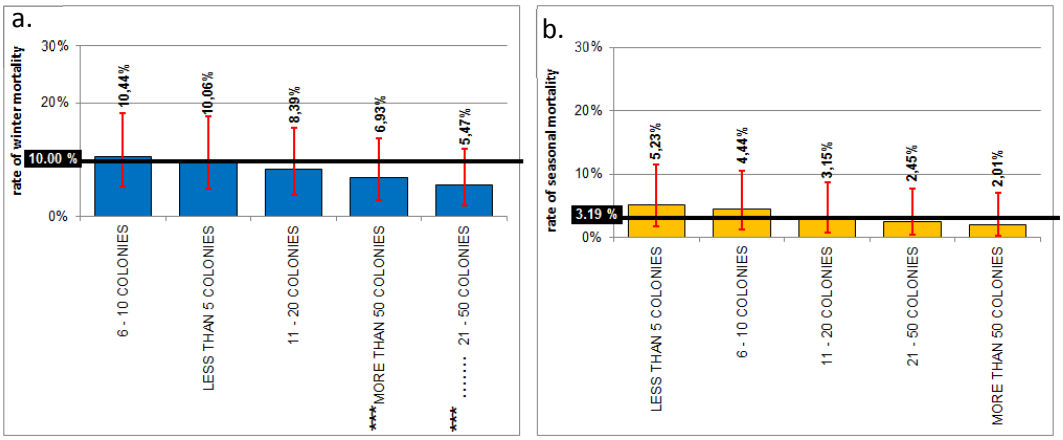


Figure 50: Effect of the variable*Apiary_size*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (3.19 %) for the seasonal mortality (b) during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

I6: Size of the operation

a. b.

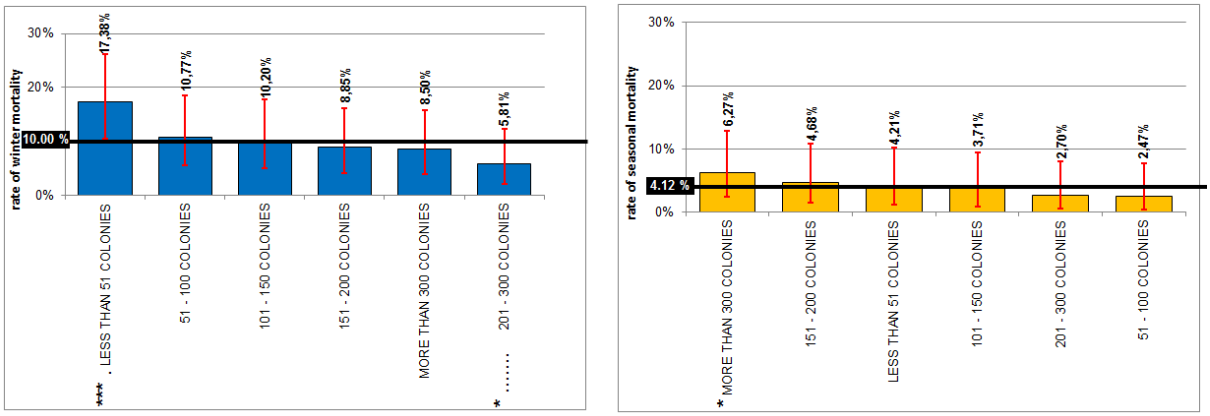


Figure 51: Effect of the variable *Bee_population_size*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.12 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

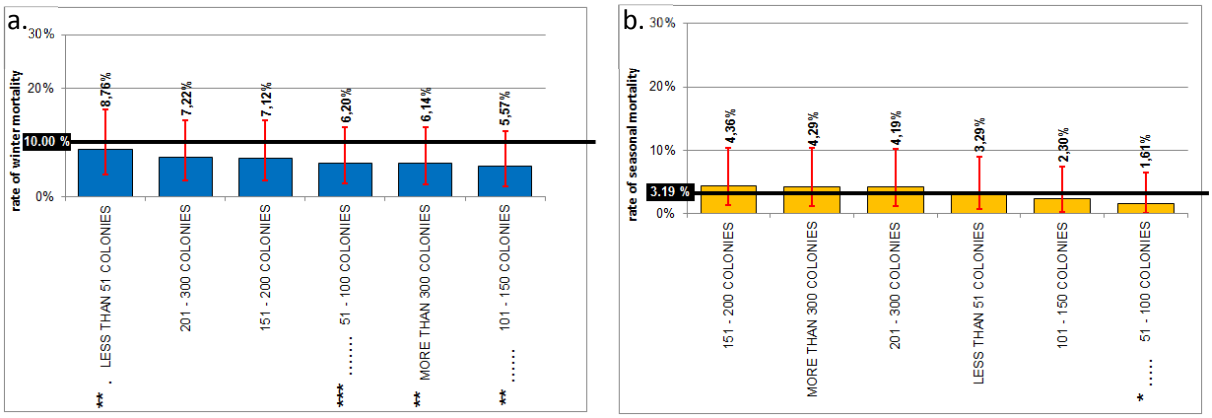


Figure 52: Effect of the variable *Bee_population_size*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (3.19 %) for the seasonal mortality (b) during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

I7: Honeybee breed

a. b.

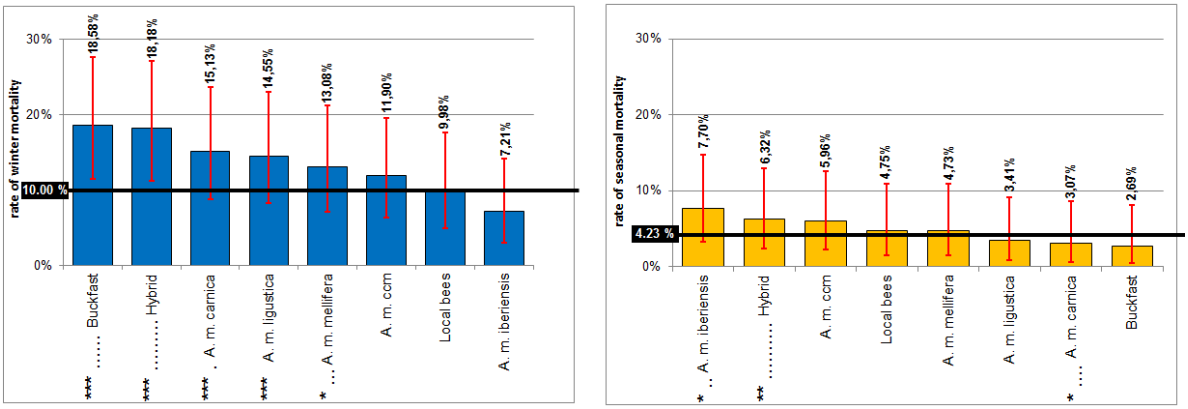


Figure 53: Effect of the variable *Breed*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.23 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

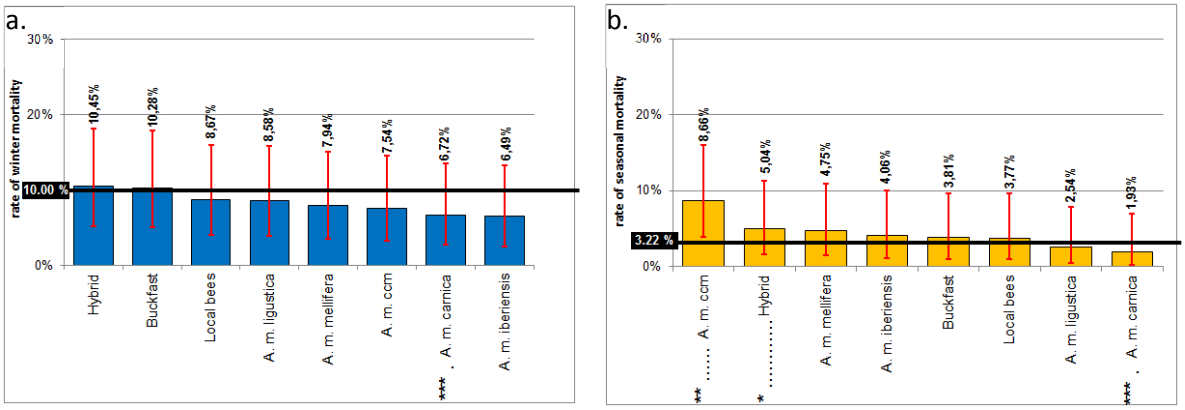


Figure 54: Effect of the variable Breed. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (3.22 %) for the seasonal mortality (b) during EPILOBEE second year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

I8: Environmental surrounding of the apiary

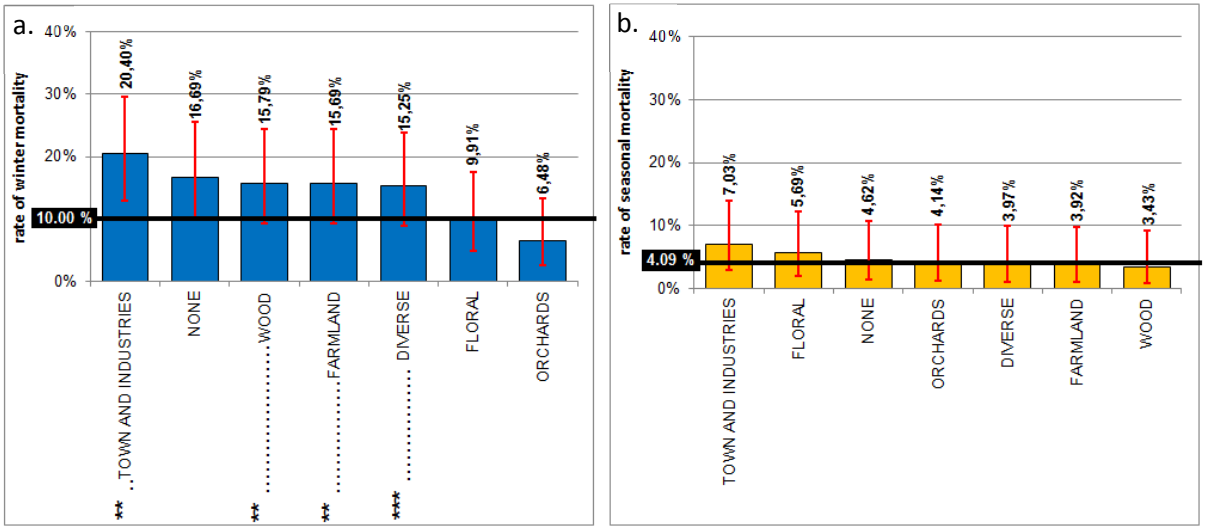


Figure 55: Effect of the variable*Environment*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.09 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

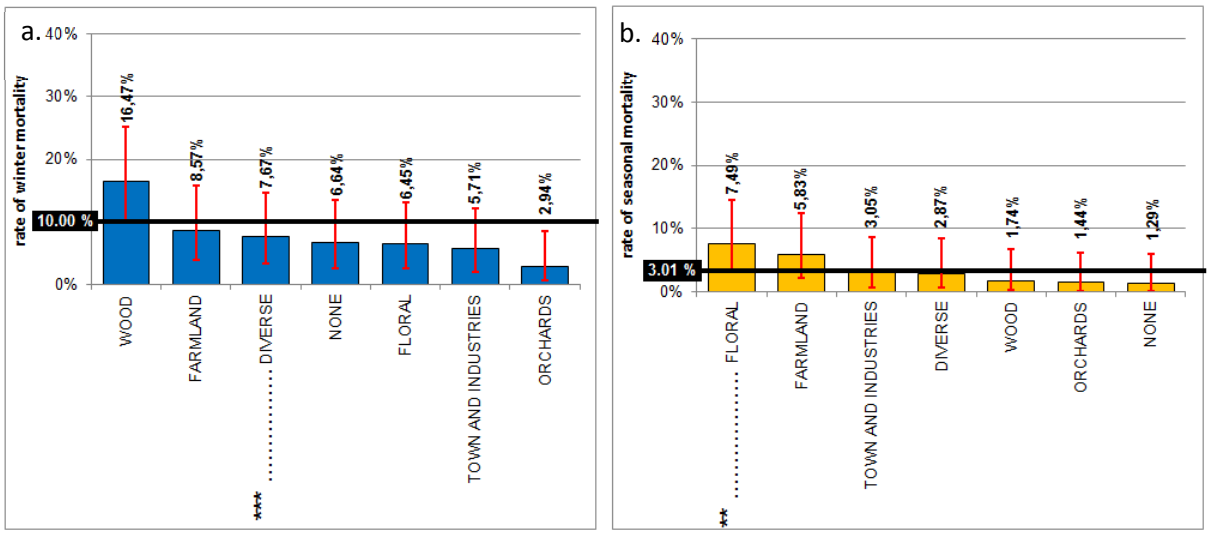


Figure 56: Effect of the variable*Environment*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (3.01 %) for the seasonal mortality (b) during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

I9: Management of the operation

a. b.

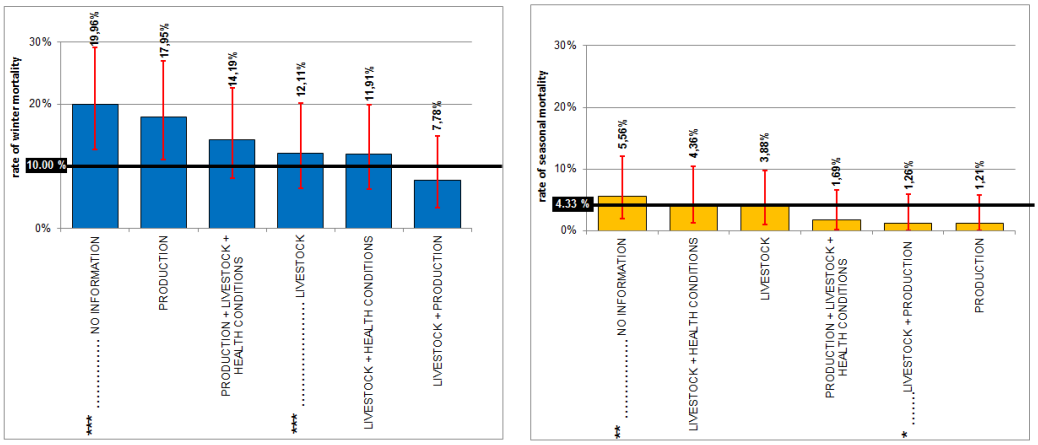


Figure 57: Effect of the variable *Management*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.33 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

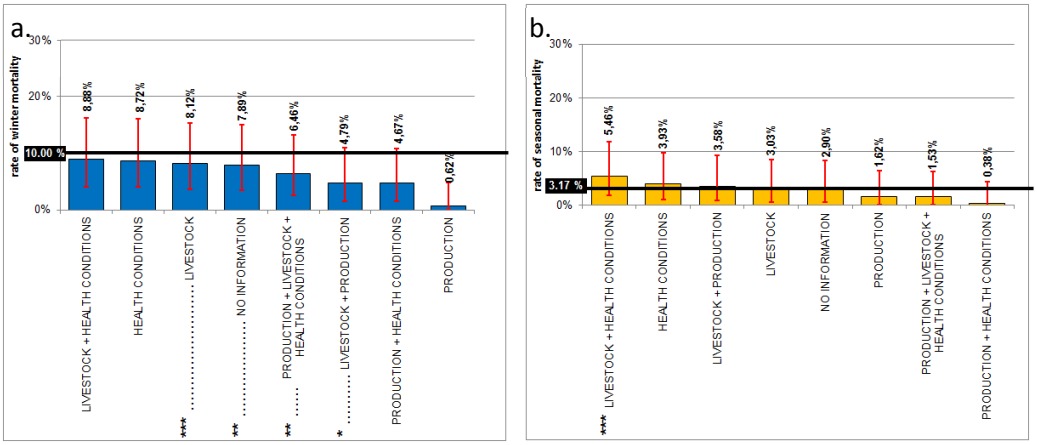


Figure 58: Effect of the variable *Management*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (3.17 %) for the seasonal mortality (b) during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

I10: Queens bought

a. b.

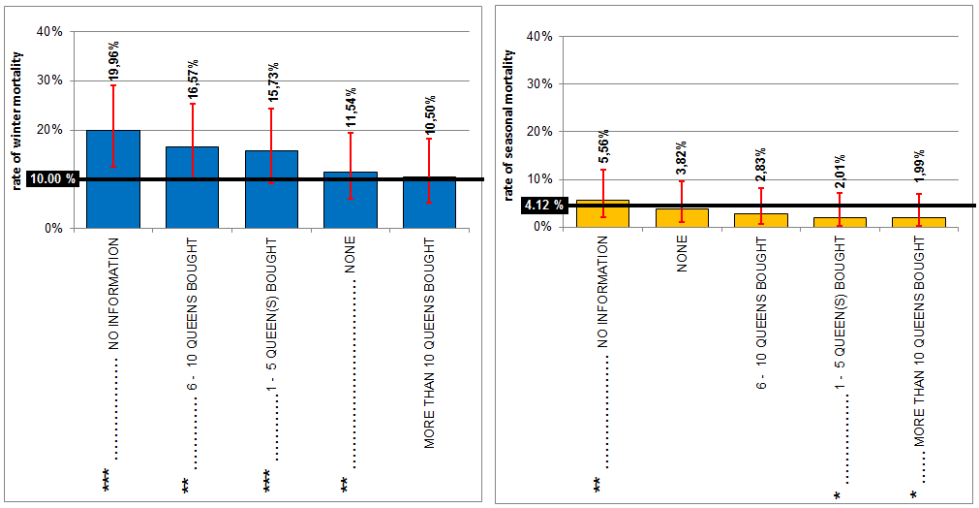


Figure 59: Effect of the variable *Queen bought*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.12 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

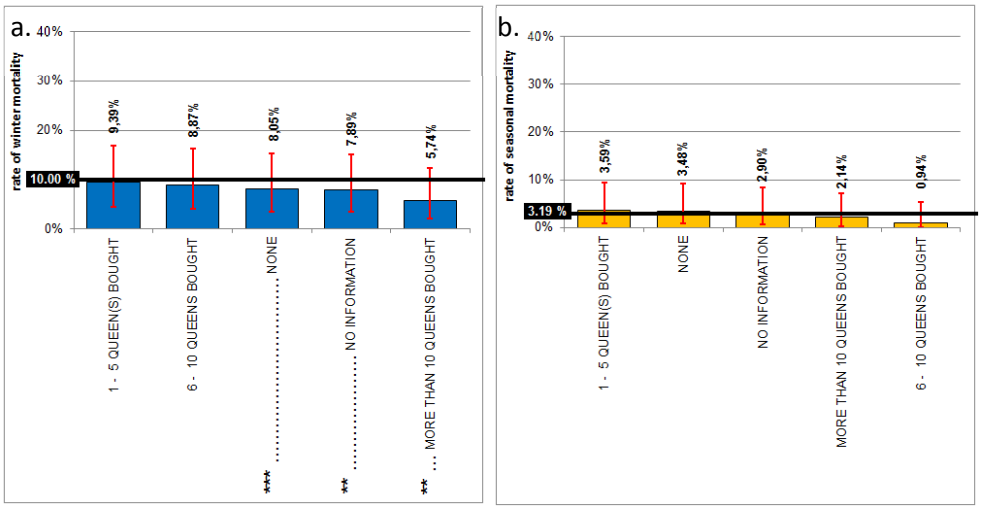


Figure 60: Effect of the variable *Queen bought*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (3.19 %) for the seasonal mortality (b) during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001)

I11: Queens produced

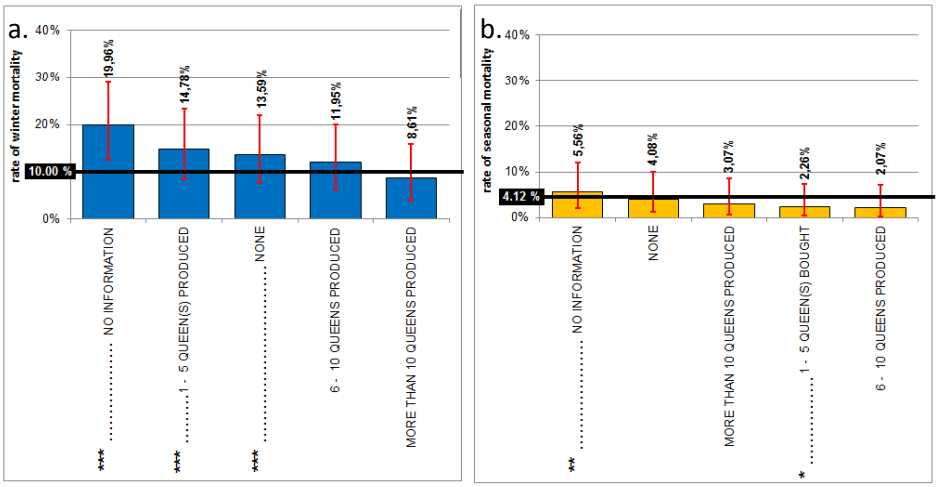


Figure 61: Effect of the variable *Queen produced*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.12 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

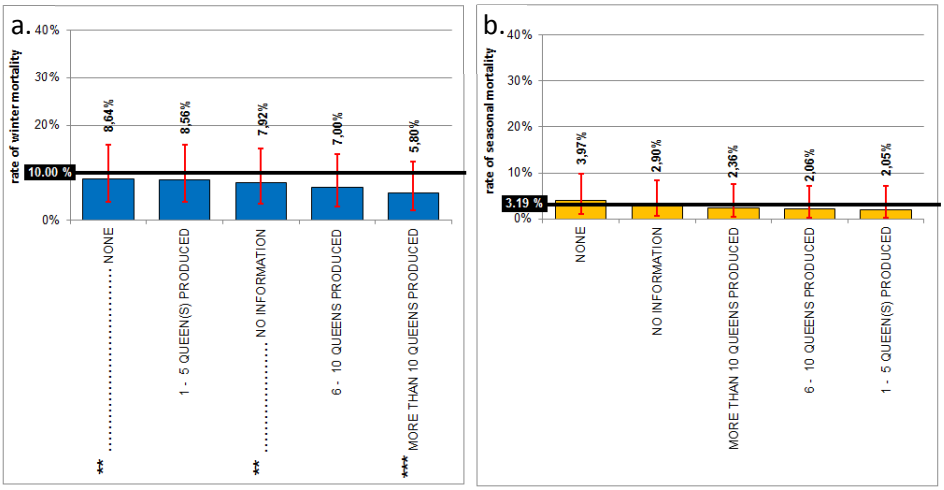


Figure 62: Effect of the variable *Queen produced*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (3.19 %) for the seasonal mortality (b) during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

I12: Swarms bought

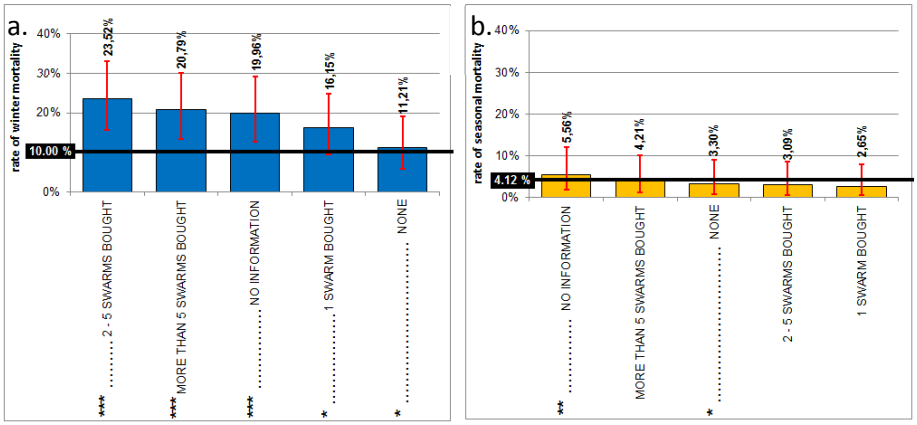


Figure 63: Effect of the variable *Swarm bought*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.12 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

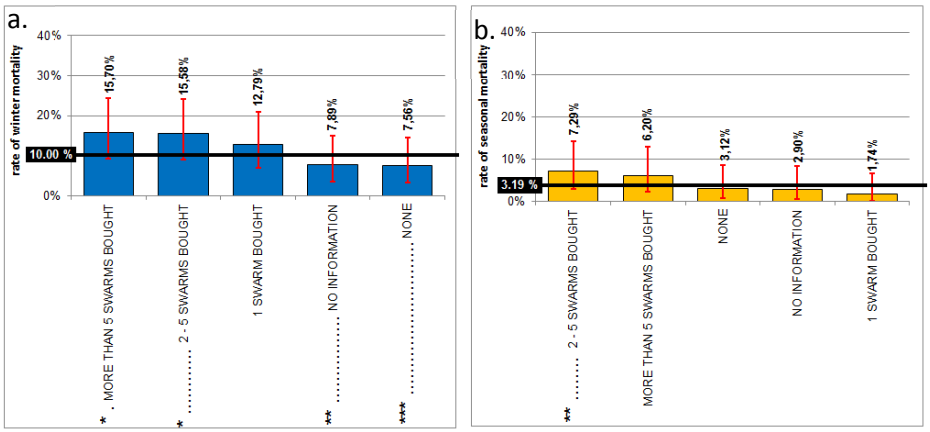


Figure 64: Effect of the variable *Swarm bought*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.12 %) for the seasonal mortality (b) during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

I13: Swarms produced

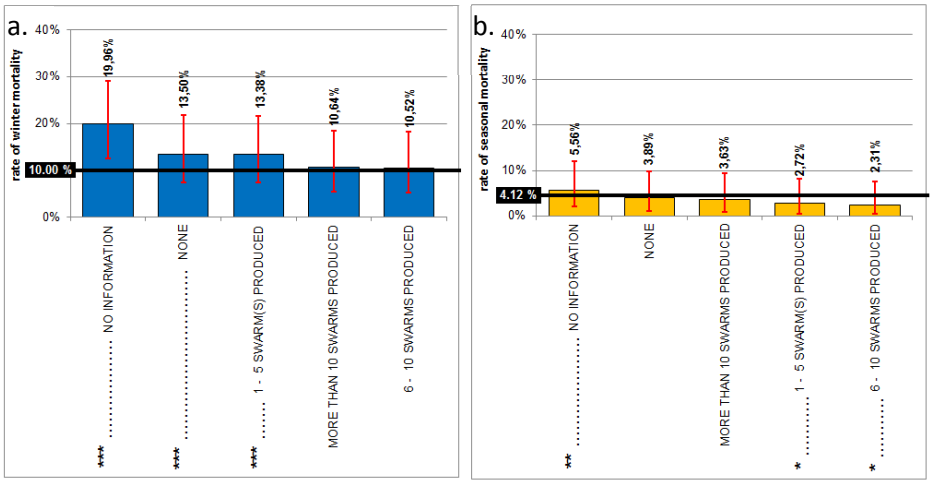


Figure 65: Effect of the variable *Swarm produced*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.12 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

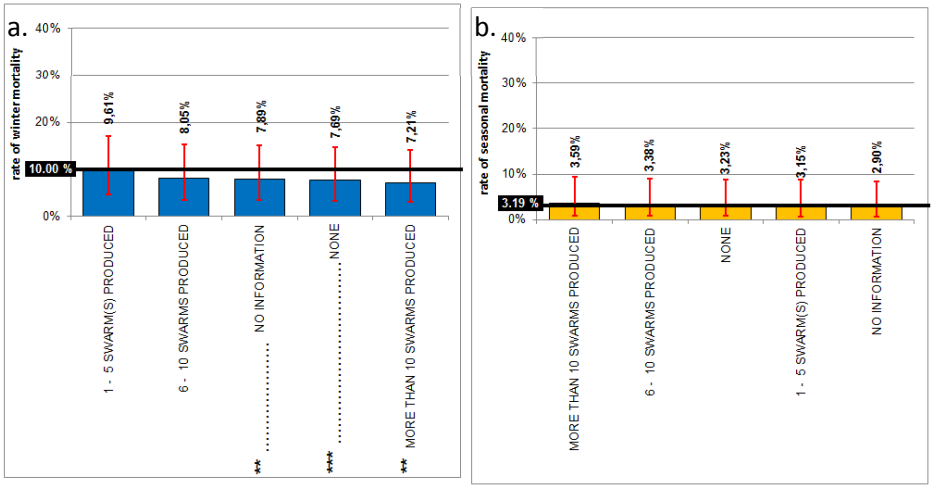


Figure 66: Effect of the variable *Swarmproduced*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (3.19 %) for the seasonal mortality (b) during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

I14: Production of the beekeeper

a. b.

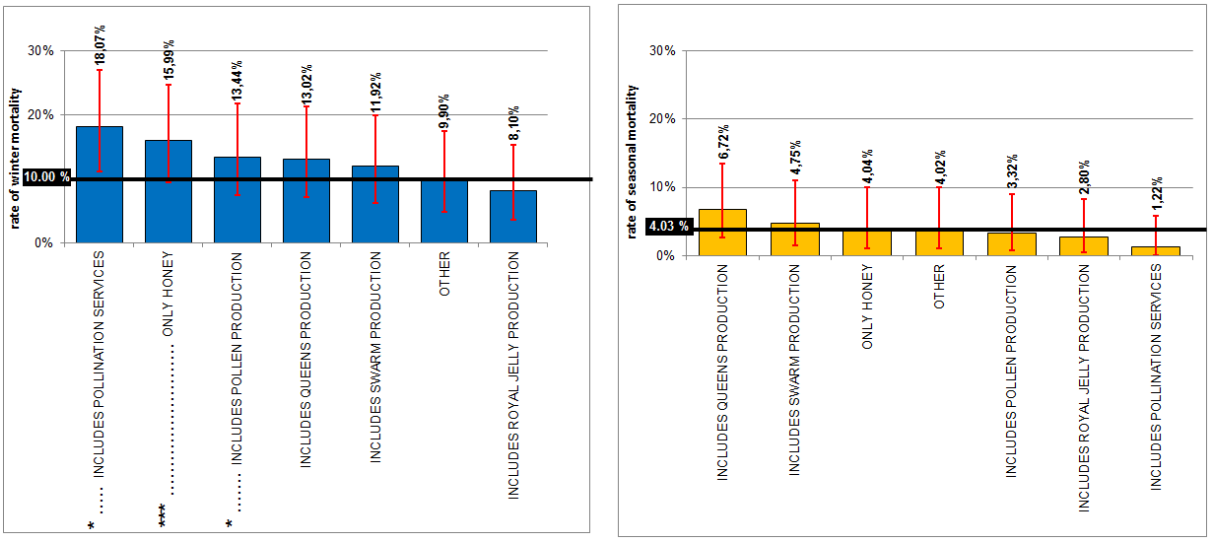


Figure 67: Effect of the variable *Production*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (4.03 %) for the seasonal mortality (b) during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

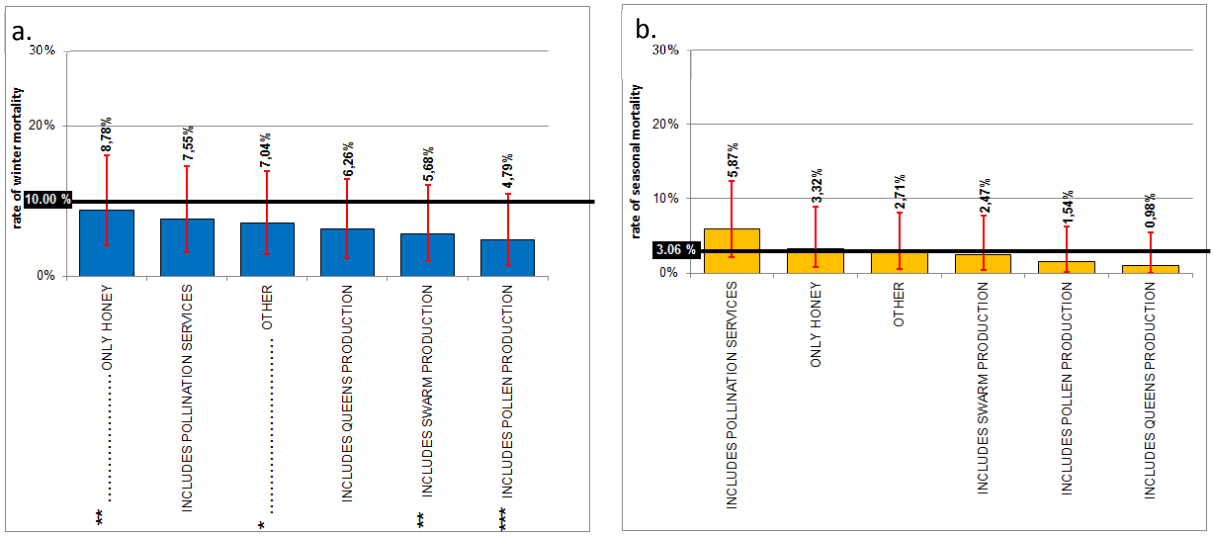


Figure 68: Effect of the variable *Production*. Comparisons to a threshold of 10 % for the winter mortality (a) and to the European mean mortality (3.06 %) for the seasonal mortality (b) during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

I15: Environment targeted during the previous seasonal migration

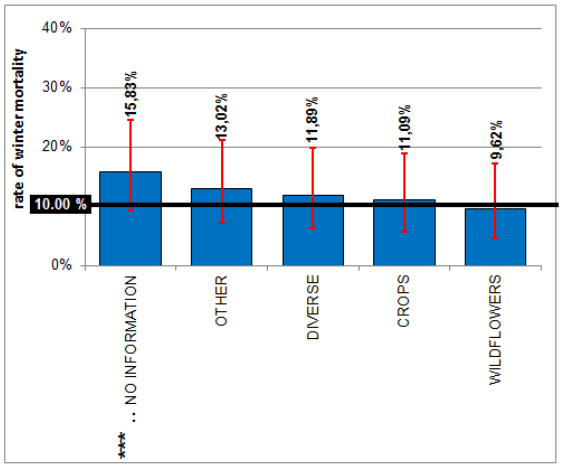


Figure 69: Effect of the variable *MidSeason_Target*. Comparisons to a threshold of 10 % for the winter mortality during EPILOBEE *first* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

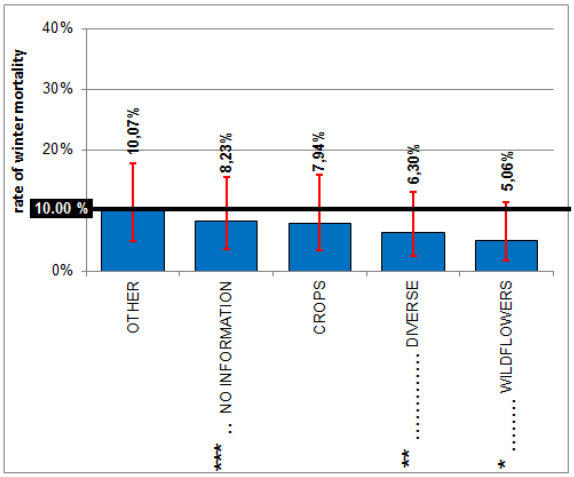


Figure 70: Effect of the variable *MidSeason_Target*. Comparisons to a threshold of 10 % for the winter mortality during EPILOBEE *second* year. The stars indicate the statistical difference (*p<0.05; **p<0.01; ***p<0.001) . The red line segments represent the 95% confidence intervals.

I16: Previous winter mortality

Please refer to 3.1.2. Study for each year of EPILOBEE : main results

Appendix J – Study for each year of EPILOBEE: pairwise comparisons between the categories of the different variables[31] included in the analysis

Each cell located at the intersection of two categories(i located at the right of the table and j located at the top of the table) stored a p-value :

- when the p-value was inferior to 0.05, the mortality rates between the two categories were statistically different (colored cell)
- when the p-value was superior to 0.05, the mortality rates were not statistically different (uncolored cell)[32]

Please refer to 3.1.2 Study for each year of EPILOBEE : main results, to get a reading example of the following table.

J1: Country

Table 31: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Country*)

BE	DK	EN & WA	EE	FI	FR	DE	GR	HU	IT	LV	LT	PL	PT	SK	ES	SE	winter mortality
	1×10^{-6}	0.03	1×10^{-4}	1×10^{-4}	$< 10^{-7}$	$< 10^{-7}$	$< 10^{-7}$	$< 10^{-7}$	$< 10^{-7}$	1×10^{-3}	$< 10^{-7}$	1×10^{-4}	1×10^{-6}	$< 10^{-7}$	$< 10^{-7}$	0.01	BE
		1×10^{-3}	0.09	0.17	0.80	0.45	1×10^{-3}	0.13	1×10^{-5}	0.21	1×10^{-4}	0.06	1.00	0.08	0.05	0.03	DK
			0.10	0.06	1×10^{-5}	1×10^{-6}	$< 10^{-7}$	1×10^{-6}	$< 10^{-7}$	0.12	$< 10^{-7}$	0.15	1×10^{-3}	$< 10^{-7}$	$< 10^{-7}$	0.46	EN & WA
				0.73	0.01	1×10^{-3}	1×10^{-6}	1×10^{-4}	$< 10^{-7}$	0.79	$< 10^{-7}$	0.85	0.08	$< 10^{-7}$	$< 10^{-7}$	0.51	EE
					0.05	0.01	1×10^{-6}	1×10^{-3}	1×10^{-7}	0.97	1×10^{-7}	0.60	0.16	1×10^{-4}	1×10^{-4}	0.34	FI
						0.54	1×10^{-3}	0.13	1×10^{-5}	0.08	1×10^{-4}	1×10^{-3}	0.79	0.07	0.04	1×10^{-3}	FR
							0.01	0.37	1×10^{-4}	0.03	1×10^{-4}	1×10^{-3}	0.44	0.25	0.16	1×10^{-3}	DE
								0.09	0.17	1×10^{-5}	0.26	1×10^{-7}	1×10^{-3}	0.12	0.20	1×10^{-7}	GR
									1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-4}	0.12	0.81	0.62	1×10^{-5}	HU
										1×10^{-7}	0.83	$< 10^{-7}$	1×10^{-5}	1×10^{-3}	1×10^{-3}	$< 10^{-7}$	IT
											1×10^{-6}	0.68	0.20	1×10^{-3}	1×10^{-4}	0.42	LV
												$< 10^{-7}$	1×10^{-4}	0.01	0.02	$< 10^{-7}$	LT
													0.05	1×10^{-5}	1×10^{-5}	0.61	PL
														0.07	0.04	0.03	PT
															0.79	1×10^{-5}	SK
																1×10^{-5}	ES
																	SE

[31] Variable with at least three categories.

[32] For a given table, when all the p-values were superior to 0.05, the closest p-value to 0.05 (and staying inferior to 0.30) were colored in red.

Table 32: Pairwise comparisons for the seasonal mortality of EPILOBEE *first* year (variable *Country*)

BE	DK	EN & WA	EE	FI	FR	DE	GR	HU	IT	LV	LT	PL	PT	SK	ES	SE	seasonal mortality
	1×10^{-3}	0.43	0.09	0.34	0.14	0.07	0.10	1×10^{-3}	0.07	0.01	0.02	1×10^{-3}	0.02	1×10^{-3}	0.95	0.01	BE
		1×10^{-3}	0.13	0.04	1×10^{-3}	0.13	0.14	0.72	0.18	0.26	0.15	0.94	0.56	0.92	1×10^{-3}	0.71	DK
			0.01	0.08	0.48	1×10^{-3}	0.01	1×10^{-4}	0.01	1×10^{-3}	0.01	1×10^{-4}	1×10^{-3}	1×10^{-5}	0.42	1×10^{-3}	EN & WA
				0.46	1×10^{-3}	0.94	0.98	0.14	0.84	0.04	0.05	0.07	0.31	0.07	0.06	0.23	EE
					0.01	0.41	0.47	0.03	0.37	0.02	0.03	0.01	0.11	0.01	0.29	0.08	FI
						1×10^{-4}	1×10^{-3}	1×10^{-5}	1×10^{-3}	1×10^{-3}	0.01	1×10^{-5}	1×10^{-4}	1×10^{-6}	0.12	1×10^{-4}	FR
							0.96	0.14	0.89	0.04	0.05	0.08	0.32	0.07	0.04	0.24	DE
								0.15	0.86	0.04	0.05	0.08	0.32	0.07	0.07	0.24	GR
									0.21	0.17	0.11	0.73	0.77	0.74	1×10^{-3}	0.96	HU
										0.05	0.05	0.12	0.41	0.11	0.05	0.30	IT
											0.48	0.22	0.13	0.21	0.01	0.17	LV
												0.13	0.09	0.13	0.02	0.11	LT
													0.55	0.97	1×10^{-4}	0.73	PL
														0.55	0.01	0.82	PT
															1×10^{-4}	0.74	SK
																0.01	ES
																	SE

Table 33: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Country*)

BE	DK	EE	FI	FR	DE	GR	HU	IT	LV	LT	PL	PT	SK	ES	SE	winter mortality
	0.10	0.47	0.03	0.14	1×10^{-6}	0.17	1×10^{-6}	1×10^{-4}	1×10^{-3}	$< 10^{-7}$	1×10^{-6}	0.03	1×10^{-7}	1×10^{-4}	0.22	BE
		0.30	0.57	0.71	1×10^{-3}	0.64	1×10^{-3}	0.02	0.17	1×10^{-7}	1×10^{-3}	0.50	1×10^{-4}	0.02	0.74	DE
			0.11	0.44	1×10^{-5}	0.31	1×10^{-5}	1×10^{-3}	0.02	$< 10^{-7}$	1×10^{-5}	0.10	1×10^{-6}	1×10^{-4}	0.54	EE
				0.33	0.01	0.89	0.01	0.07	0.41	1×10^{-6}	1×10^{-3}	0.89	1×10^{-3}	0.09	0.39	FI
					1×10^{-4}	0.50	1×10^{-4}	1×10^{-3}	0.07	1×10^{-7}	1×10^{-4}	0.29	1×10^{-5}	1×10^{-3}	0.98	FR
						0.13	0.87	0.60	0.09	1×10^{-3}	0.98	0.02	0.50	0.32	1×10^{-3}	DE
							0.16	0.28	0.71	1×10^{-4}	0.12	0.96	0.05	0.38	0.51	GR
								0.70	0.12	1×10^{-3}	0.85	0.02	0.40	0.40	1×10^{-3}	HU
									0.30	1×10^{-3}	0.58	0.10	0.25	0.71	0.01	IT
										1×10^{-5}	0.08	0.52	0.02	0.44	0.10	LV
											1×10^{-5}	1×10^{-6}	0.02	1×10^{-4}	1×10^{-7}	LT
												0.01	0.50	0.30	1×10^{-4}	PL
													1×10^{-3}	0.15	0.34	PT
														0.09	1×10^{-4}	SK
															0.01	ES
																SE

Table 34: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Country*)

BE	DK	EE	FI	FR	DE	GR	HU	IT	LV	LT	PL	PT	SK	ES	SE	seasonal mortality
	0.03	1×10^{-5}	1×10^{-5}	0.95	1×10^{-4}	0.35	1×10^{-5}	1×10^{-3}	1×10^{-5}	1×10^{-4}	1×10^{-5}	1×10^{-3}	1×10^{-6}	0.09	1×10^{-3}	BE
		1×10^{-3}	1×10^{-3}	0.01	0.10	0.74	0.01	0.28	1×10^{-3}	1×10^{-3}	1×10^{-4}	0.27	1×10^{-3}	0.57	0.28	DE
			0.87	1×10^{-6}	0.25	0.02	0.93	0.14	0.22	0.04	0.02	0.14	0.71	1×10^{-3}	0.13	EE
				1×10^{-5}	0.22	0.02	0.81	0.13	0.30	0.05	0.03	0.13	0.85	1×10^{-3}	0.12	FI
					1×10^{-5}	0.32	1×10^{-6}	1×10^{-3}	1×10^{-5}	1×10^{-4}	1×10^{-5}	1×10^{-3}	1×10^{-6}	0.02	1×10^{-3}	FR
						0.16	0.29	0.68	0.04	0.01	1×10^{-3}	0.68	0.14	0.03	0.67	DE
							0.03	0.29	1×10^{-3}	1×10^{-3}	1×10^{-3}	0.29	0.01	0.99	0.29	GR

J2: Beekeeper activity

Table 35: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Activity*)

HOBBY	PART TIME	PROFESSIONAL	winter mortality
	9×10^{-4}	$< 10^{-7}$	HOBBY
		2×10^{-3}	PART TIME
			PROFESSIONAL

Table 36: Pairwise comparisons for the seasonal mortality of EPILOBEE *first* year (variable *Activity*)

HOBBY	PART TIME	PROFESSIONAL	seasonal mortality
	0.12	0.90	HOBBY
		0.22	PART TIME
			PROFESSIONAL

Table 37: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Activity*)

HOBBY	PART TIME	PROFESSIONAL	winter mortality
	0.04	0.07	HOBBY
		0.82	PART TIME
			PROFESSIONAL

Table 38: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Activity*)

HOBBY	PART TIME	PROFESSIONAL	seasonal mortality
	0.91	0.94	HOBBY
		0.74	PART TIME
			PROFESSIONAL

J3: Beekeeper age

Table 39: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Age*)

LESS THAN 30	30 - 45	45 - 65	OVER 65	winter mortality
	0.32	0.68	0.10	LESS THAN 30
		0.19	0.22	30 - 45
			5×10^{-3}	45 - 65
				OVER 65

Table 40: Pairwise comparisons for the seasonal mortality of EPILOBEE *first* year (variable *Age*)

LESS THAN 30	30 - 45	45 - 65	OVER 65	seasonal mortality
	0.62	0.52	0.20	LESS THAN 30
		0.91	0.10	30 - 45
			0.07	45 - 65
				OVER 65

Table 41: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Age*)

LESS THAN 30	30 - 45	45 - 65	OVER 65	winter mortality
	0.24	0.55	0.29	LESS THAN 30
		0.17	0.81	30 - 45
			0.26	45 - 65
				OVER 65

Table 42: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Age*)

LESS THAN 30	30 - 45	45 - 65	OVER 65	seasonal mortality
	0.80	0.34	0.64	LESS THAN 30
		0.19	0.72	30 - 45
			0.35	45 - 65
				OVER 65

J4: Beekeeper experience

Table 43: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Beekeep_for*)

LESS THAN 2 YEARS	2 - 5 YEARS	MORE THAN 5 YEARS	winter mortality
	0.25	0.02	LESS THAN 2 YEARS
		0.20	2 - 5 YEARS
			MORE THAN 5 YEARS

Table 44: Pairwise comparisons for the seasonal mortality of EPILOBEE *first* year (variable *Beekeep_for*)

LESS THAN 2 YEARS	2 - 5 YEARS	MORE THAN 5 YEARS	seasonal mortality
	0.57	0.76	LESS THAN 2 YEARS
		0.64	2 - 5 YEARS
			MORE THAN 5 YEARS

Table 45: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Beekeep_for*)

LESS THAN 2 YEARS	2 - 5 YEARS	MORE THAN 5 YEARS	winter mortality
	0.28	0.98	LESS THAN 2 YEARS
		0.16	2 - 5 YEARS
			MORE THAN 5 YEARS

Table 46: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Beekeep_for*)

LESS THAN 2 YEARS	2 - 5 YEARS	MORE THAN 5 YEARS	seasonal mortality
	0.91	0.94	LESS THAN 2 YEARS
		0.75	2 - 5 YEARS
			MORE THAN 5 YEARS

J5: Size of the apiary

Table 47: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Apiary_size*)

LESS THAN 5 COLONIES	6 - 10 COLONIES	11 - 20 COLONIES	21 - 50 COLONIES	MORE THAN 50 COLONIES	winter mortality
	0.67	2×10^{-3}	2×10^{-6}	$< 10^{-7}$	LESS THAN 5 COLONIES
		0.01	2×10^{-5}	$< 10^{-7}$	6 - 10 COLONIES
			0.11	3×10^{-7}	11 - 20 COLONIES
				3×10^{-4}	21 - 50 COLONIES
					MORE THAN 50 COLONIES

Table 48: Pairwise comparisonsfor the seasonal mortality of EPILOBEE *first* year (variable *Apiary_size*)

LESS THAN 5 COLONIES	6 - 10 COLONIES	11 - 20 COLONIES	21 - 50 COLONIES	MORE THAN 50 COLONIES	seasonal mortality
	0.30	0.52	0.03	0.08	LESS THAN 5 COLONIES
		0.74	0.26	0.46	6 - 10 COLONIES
			0.16	0.30	11 - 20 COLONIES
				0.70	21 - 50 COLONIES
					MORE THAN 50 COLONIES

Table 49: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Apiary_size*)

LESS THAN 5 COLONIES	6 - 10 COLONIES	11 - 20 COLONIES	21 - 50 COLONIES	MORE THAN 50 COLONIES	winter mortality
	0.75	0.16	4×10^{-5}	9×10^{-5}	LESS THAN 5 COLONIES
		0.12	4×10^{-5}	9×10^{-4}	6 - 10 COLONIES
			0.01	0.12	11 - 20 COLONIES
				0.10	21 - 50 COLONIES
					MORE THAN 50 COLONIES

Table 50: Pairwise comparisonsfor the seasonal mortality of EPILOBEE *second* year (variable *Apiary_size*)

LESS THAN 5 COLONIES	6 - 10 COLONIES	11 - 20 COLONIES	21 - 50 COLONIES	MORE THAN 50 COLONIES	seasonal mortality
	0.38	0.02	0.01	$< 10^{-7}$	LESS THAN 5 COLONIES
		0.16	0.02	8×10^{-5}	6 - 10 COLONIES
			0.38	0.06	11 - 20 COLONIES
				0.43	21 - 50 COLONIES
					MORE THAN 50 COLONIES

J6: Size of the operation

Table 51: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Bee_population_size*)

LESS THAN 51 COLONIES	51 - 100 COLONIES	101 - 150 COLONIES	151 - 200 COLONIES	201 - 300 COLONIES	MORE THAN 300 COLONIES	winter mortality
	3×10^{-5}	3×10^{-3}	3×10^{-3}	5×10^{-5}	2×10^{-6}	LESS THAN 51 COLONIES
		0.79	0.43	0.03	0.20	51 - 100 COLONIES
			0.62	0.07	0.42	101 - 150 COLONIES
				0.22	0.88	151 - 200 COLONIES
					0.21	201 - 300 COLONIES
						MORE THAN 300 COLONIES

Table 52: Pairwise comparisons for the seasonal mortality of EPILOBEE *first* year (variable *Bee_population_size*)

LESS THAN 51 COLONIES	51 - 100 COLONIES	101 - 150 COLONIES	151 - 200 COLONIES	201 - 300 COLONIES	MORE THAN 300 COLONIES	seasonal mortality
	0.06	0.71	0.77	0.33	0.06	LESS THAN 51 COLONIES
		0.33	0.15	0.87	5×10^{-2}	51 - 100 COLONIES
			0.63	0.57	0.17	101 - 150 COLONIES
				0.34	0.47	151 - 200 COLONIES
					0.09	201 - 300 COLONIES
						MORE THAN 300 COLONIES

Table 53: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Bee_population_size*)

LESS THAN 51 COLONIES	51 - 100 COLONIES	101 - 150 COLONIES	151 - 200 COLONIES	201 - 300 COLONIES	MORE THAN 300 COLONIES	winter mortality
	9×10^{-3}	0.04	0.32	0.40	0.03	LESS THAN 51 COLONIES
		0.68	0.56	0.55	0.96	51 - 100 COLONIES
			0.42	0.42	0.73	101 - 150 COLONIES
				0.96	0.57	151 - 200 COLONIES
					0.56	201 - 300 COLONIES
						MORE THAN 300 COLONIES

Table 54: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Bee_population_size*)

LESS THAN 51 COLONIES	51 - 100 COLONIES	101 - 150 COLONIES	151 - 200 COLONIES	201 - 300 COLONIES	MORE THAN 300 COLONIES	seasonal mortality
	0.01	0.37	0.36	0.49	0.26	LESS THAN 51 COLONIES
		0.47	0.02	0.03	6×10^{-3}	51 - 100 COLONIES
			0.20	0.26	0.17	101 - 150 COLONIES
				0.92	0.96	151 - 200 COLONIES
					0.95	201 - 300 COLONIES
						MORE THAN 300 COLONIES

J7: Honeybee breed

Table 55: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Breed*)

A. m. carnica	A. m. ccm	A. m. iberiensis	A. m. ligustica	A. m. mellifera	Buckfast	Hybrid	Local bees	winter mortality
	0.32	6×10^{-3}	0.74	0.26	0.06	0.04	2×10^{-3}	A. m. carnica
		0.16	0.44	0.72	0.08	0.09	0.51	A. m. ccm
			0.01	0.04	8×10^{-4}	8×10^{-4}	0.27	A. m. iberiensis
				0.48	0.07	0.07	0.02	A. m. ligustica
					0.01	0.01	0.10	A. m. mellifera
						0.84	5×10^{-5}	Buckfast
							2×10^{-5}	Hybrid
								Local bees

Table 56: Pairwise comparisons for the seasonal mortality of EPILOBEE *first* year (variable *Breed*)

A. m. carnica	A. m. ccm	A. m. iberiensis	A. m. ligustica	A. m. mellifera	Buckfast	Hybrid	Local bees	seasonal mortality
	0.09	4×10^{-3}	0.70	0.09	0.66	2×10^{-4}	0.07	A. m. carnica
		0.59	0.21	0.59	0.08	0.88	0.59	A. m. ccm
			0.03	0.17	7×10^{-3}	0.54	0.17	A. m. iberiensis
				0.30	0.50	0.02	0.28	A. m. ligustica
					0.09	0.24	0.99	A. m. mellifera
						3×10^{-3}	0.09	Buckfast
							0.24	Hybrid
								Local bees

Table 57: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Breed*)

A. m. carnica	A. m. ccm	A. m. iberiensis	A. m. ligustica	A. m. mellifera	Buckfast	Hybrid	Local bees	winter mortality
	0.73	0.89	0.07	0.33	2×10^{-4}	9×10^{-4}	0.04	A. m. carnica
		0.71	0.71	0.89	0.36	0.35	0.69	A. m. ccm
			0.30	0.49	0.08	0.08	0.28	A. m. iberiensis
				0.69	0.21	0.21	0.94	A. m. ligustica
					0.15	0.16	0.64	A. m. mellifera
						0.91	0.20	Buckfast
							0.21	Hybrid
								Local bees

Table 58: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Breed*)

A. m. carnica	A. m. ccm	A. m. iberiensis	A. m. ligustica	A. m. mellifera	Buckfast	Hybrid	Local bees	seasonal mortality
	1×10^{-4}	0.06	0.34	1×10^{-3}	3×10^{-3}	8×10^{-5}	4×10^{-3}	A. m. carnica
		0.14	4×10^{-3}	0.16	0.04	0.18	0.04	A. m. ccm
			0.28	0.71	0.88	0.60	0.85	A. m. iberiensis
				0.06	0.17	0.02	0.18	A. m. ligustica
					0.45	0.85	0.43	A. m. mellifera
						0.27	0.96	Buckfast
							0.25	Hybrid
								Local bees

J8: Environmental surrounding of the apiary

Table 59: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Environment*)

DIVERSE	FARMLAND	FLORAL	NONE	ORCHARDS	TOWN & INDUSTRIES	WOOD	winter mortality
	0.09	0.03	0.82	0.04	0.19	0.88	DIVERSE
		0.06	0.88	0.06	0.33	0.98	FARMLAND
			0.24	0.37	0.01	0.12	FLORAL
				0.11	0.66	0.90	NONE
					0.01	0.07	ORCHARDS
						0.42	TOWN & INDUSTRIES
							WOOD

Table 60: Pairwise comparisons for the seasonal mortality of EPILOBEE *first* year (variable *Environment*)

DIVERSE	FARMLAND	FLORAL	NONE	ORCHARDS	TOWN & INDUSTRIES	WOOD	seasonal mortality
	0.97	0.22	0.86	0.95	0.18	0.79	DIVERSE
		0.40	0.86	0.93	0.28	0.84	FARMLAND
			0.81	0.63	0.68	0.41	FLORAL
				0.92	0.66	0.77	NONE
					0.47	0.82	ORCHARDS
						0.30	TOWN & INDUSTRIES
							WOOD

Table 61: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Environment*)

DIVERSE	FARMLAND	FLORAL	NONE	ORCHARDS	TOWN & INDUSTRIES	WOOD	winter mortality
	0.70	0.57	0.79	0.21	0.54	0.01	DIVERSE
		0.49	0.68	0.19	0.47	0.11	FARMLAND
			0.96	0.34	0.83	0.03	FLORAL
				0.39	0.84	0.15	NONE
					0.46	0.04	ORCHARDS
						0.06	TOWN & INDUSTRIES
							WOOD

Table 62: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Environment*)

DIVERSE	FARMLAND	FLORAL	NONE	ORCHARDS	TOWN & INDUSTRIES	WOOD	seasonal mortality
	0.07	3×10^{-3}	0.57	0.58	0.94	0.63	DIVERSE
		0.62	0.30	0.28	0.44	0.28	FARMLAND
			0.22	0.20	0.27	0.18	FLORAL
				0.95	0.59	0.86	NONE
					0.60	0.91	ORCHARDS
						0.66	TOWN & INDUSTRIES
							WOOD

J9: Management of the operation

Table 63: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Management*)

LIVESTOCK	LIVESTOCK + HEALTH CONDITIONS	NO INFOTMATION	PRODUCTION	LIVESTOCK + PRODUCTION	PRODUCTION + LIVESTOCK + HEALTH CONDITIONS	winter mortality
	0.97	$< 10^{-7}$	0.22	0.02	0.49	LIVESTOCK
		0.16	0.40	0.30	0.68	LIVESTOCK + HEALTH CONDITIONS
			0.74	1×10^{-6}	0.14	NO INFOTMATION
				0.02	0.54	PRODUCTION
					0.04	LIVESTOCK + PRODUCTION
						PRODUCTION + LIVESTOCK + HEALTH CONDITIONS

Table 64: Pairwise comparisons for the seasonal mortality of EPILOBEE *first* year (variable *Management*)

LIVESTOCK	LIVESTOCK + HEALTH CONDITIONS	NO INFOTMATION	PRODUCTION	LIVESTOCK + PRODUCTION	PRODUCTION + LIVESTOCK + HEALTH CONDITIONS	seasonal mortality
	0.86	9×10^{-3}	0.38	0.03	0.24	LIVESTOCK
		0.71	0.38	0.13	0.32	LIVESTOCK + HEALTH CONDITIONS
			0.25	4×10^{-3}	0.09	NO INFOTMATION
				0.98	0.82	PRODUCTION
					0.74	LIVESTOCK + PRODUCTION
						PRODUCTION + LIVESTOCK + HEALTH CONDITIONS

Table 65: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Management*)

HEALTH CONDITIONS	LIVESTOCK	LIVESTOCK + HEALTH CONDITIONS	NO INFOTMATION	PRODUCTION	PRODUCTION + HEALTH CONDITIONS	LIVESTOCK + PRODUCTION	PRODUCTION + LIVESTOCK + HEALTH CONDITIONS	winter mortality
	0.73	0.94	0.65	0.07	0.27	0.09	0.26	HEALTH CONDITIONS
		0.48	0.77	0.08	0.30	0.07	0.19	LIVESTOCK
			0.39	0.07	0.24	0.04	0.11	LIVESTOCK + HEALTH CONDITIONS
				0.08	0.33	0.09	0.27	NO INFOTMATION
					0.20	0.17	0.11	PRODUCTION
						0.97	0.56	PRODUCTION + HEALTH CONDITIONS
							0.37	LIVESTOCK + PRODUCTION
								PRODUCTION + LIVESTOCK + HEALTH CONDITIONS

Table 66: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Management*)

HEALTH CONDITIONS	LIVESTOCK	LIVESTOCK + HEALTH CONDITIONS	NO INFOTMATION	PRODUCTION	PRODUCTION + HEALTH CONDITIONS	LIVESTOCK + PRODUCTION	PRODUCTION + LIVESTOCK + HEALTH CONDITIONS	seasonal mortality
	0.46	0.39	0.41	0.41	0.27	0.85	0.07	HEALTH CONDITIONS
		1×10^{-3}	0.81	0.54	0.32	0.66	0.08	LIVESTOCK
			3×10^{-3}	0.24	0.21	0.30	3×10^{-3}	LIVESTOCK + HEALTH CONDITIONS
				0.57	0.33	0.60	0.11	NO INFOTMATION
					0.53	0.46	0.96	PRODUCTION
						0.29	0.51	PRODUCTION + HEALTH CONDITIONS
							0.11	LIVESTOCK + PRODUCTION
								PRODUCTION + LIVESTOCK + HEALTH CONDITIONS

J10: Queen bought

Table 67: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Queen bought*)

NONE	1 - 5 QUEEN(S) BOUGHT	6 - 10 QUEENS BOUGHT	MORE THAN 10 QUEENS BOUGHT	NO INFORMATION	winter mortality
	0.01	0.03	0.51	$< 10^{-7}$	NONE
		0.79	0.02	0.04	1 - 5 QUEEN(S) BOUGHT
			0.02	0.26	6 - 10 QUEENS BOUGHT
				4×10^{-6}	MORE THAN 10 QUEENS BOUGHT
					NO INFORMATION

Table 68: Pairwise comparisons for the seasonal mortality of EPILOBEE *first* year (variable *Queen bought*)

NONE	1 - 5 QUEEN(S) BOUGHT	6 - 10 QUEENS BOUGHT	MORE THAN 10 QUEENS BOUGHT	NO INFORMATION	seasonal mortality
	0.06	0.49	0.06	6×10^{-3}	NONE
		0.52	0.99	3×10^{-3}	1 - 5 QUEEN(S) BOUGHT
			0.51	0.11	6 - 10 QUEENS BOUGHT
				2×10^{-3}	MORE THAN 10 QUEENS BOUGHT
					NO INFORMATION

Table 69: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Queen bought*)

NONE	1 - 5 QUEEN(S) BOUGHT	6 - 10 QUEENS BOUGHT	MORE THAN 10 QUEENS BOUGHT	NO INFORMATION	winter mortality
	0.22	0.64	0.09	0.83	NONE
		0.81	0.03	0.21	1 - 5 QUEEN(S) BOUGHT
			0.12	0.59	6 - 10 QUEENS BOUGHT
				0.13	MORE THAN 10 QUEENS BOUGHT
					NO INFORMATION

Table 70: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Queen bought*)

NONE	1 - 5 QUEEN(S) BOUGHT	6 - 10 QUEENS BOUGHT	MORE THAN 10 QUEENS BOUGHT	NO INFORMATION	seasonal mortality
	0.90	0.07	0.19	0.30	NONE
		0.07	0.22	0.42	1 - 5 QUEEN(S) BOUGHT
			0.30	0.12	6 - 10 QUEENS BOUGHT
				0.43	MORE THAN 10 QUEENS BOUGHT
					NO INFORMATION

J11: Queen produced

Table 71: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Queen produced*)

NONE	1 - 5 QUEEN(S) PRODUCED	6 - 10 QUEENS PRODUCED	MORE THAN 10 QUEENS PRODUCED	NO INFORMATION	winter mortality
	0.47	0.39	5×10^{-5}	$3 < 10^{-7}$	NONE
		0.21	9×10^{-5}	6×10^{-3}	1 - 5 QUEEN(S) PRODUCED
			0.04	3×10^{-4}	6 - 10 QUEENS PRODUCED
				$3 < 10^{-7}$	MORE THAN 10 QUEENS PRODUCED
					NO INFORMATION

Table 72: Pairwise comparisons for the seasonal mortality of EPILOBEE *first* year (variable *Queen produced*)

NONE	1 - 5 QUEEN(S) PRODUCED	6 - 10 QUEENS PRODUCED	MORE THAN 10 QUEENS PRODUCED	NO INFORMATION	seasonal mortality
	0.06	0.07	0.18	0.04	NONE
		0.85	0.35	2×10^{-3}	1 - 5 QUEEN(S) PRODUCED
			0.32	7×10^{-3}	6 - 10 QUEENS PRODUCED
				3×10^{-3}	MORE THAN 10 QUEENS PRODUCED
					NO INFORMATION

Table 73: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Queen produced*)

NONE	1 - 5 QUEEN(S) PRODUCED	6 - 10 QUEENS PRODUCED	MORE THAN 10 QUEENS PRODUCED	NO INFORMATION	winter mortality
	0.93	0.30	4×10^{-3}	0.35	NONE
		0.36	0.02	0.55	1 - 5 QUEEN(S) PRODUCED
			0.42	0.56	6 - 10 QUEENS PRODUCED
				0.04	MORE THAN 10 QUEENS PRODUCED
					NO INFORMATION

Table 74: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Queen produced*)

NONE	1 - 5 QUEEN(S) PRODUCED	6 - 10 QUEENS PRODUCED	MORE THAN 10 QUEENS PRODUCED	NO INFORMATION	seasonal mortality
	0.01	0.12	0.03	0.07	NONE
		0.99	0.67	0.23	1 - 5 QUEEN(S) PRODUCED
			0.77	0.43	6 - 10 QUEENS PRODUCED
				0.44	MORE THAN 10 QUEENS PRODUCED
					NO INFORMATION

J12: Swarm bought

Table 75: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Swarm bought*)

NONE	1 SWARM BOUGHT	2 - 5 SWARMS BOUGHT	MORE THAN 5 SWARMS BOUGHT	NO INFORMATION	winter mortality
	0.11	8×10^{-6}	8×10^{-4}	4×10^{-6}	NONE
		0.18	0.37	0.36	1 SWARM BOUGHT
			0.59	0.32	2 - 5 SWARMS BOUGHT
				0.81	MORE THAN 5 SWARMS BOUGHT
					NO INFORMATION

Table 76: Pairwise comparisons for the seasonal mortality of EPILOBEE *first* year (variable *Swarm bought*)

NONE	1 SWARM BOUGHT	2 - 5 SWARMS BOUGHT	MORE THAN 5 SWARMS BOUGHT	NO INFORMATION	seasonal mortality
	0.73	0.90	0.55	1×10^{-4}	NONE
		0.85	0.53	0.24	1 SWARM BOUGHT
			0.62	0.24	2 - 5 SWARMS BOUGHT
				0.50	MORE THAN 5 SWARMS BOUGHT
					NO INFORMATION

Table 77: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Swarm bought*)

NONE	1 SWARM BOUGHT	2 - 5 SWARMS BOUGHT	MORE THAN 5 SWARMS BOUGHT	NO INFORMATION	winter mortality
	0.03	1×10^{-4}	7×10^{-4}	0.63	NONE
		0.51	0.52	0.06	1 SWARM BOUGHT
			0.97	5×10^{-4}	2 - 5 SWARMS BOUGHT
				2×10^{-3}	MORE THAN 5 SWARMS BOUGHT
					NO INFORMATION

Table 78: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Swarm bought*)

NONE	1 SWARM BOUGHT	2 - 5 SWARMS BOUGHT	MORE THAN 5 SWARMS BOUGHT	NO INFORMATION	seasonal mortality
	0.43	7×10^{-3}	0.08	0.66	NONE
		0.07	0.13	0.50	1 SWARM BOUGHT
			0.74	6×10^{-3}	2 - 5 SWARMS BOUGHT
				0.06	MORE THAN 5 SWARMS BOUGHT
					NO INFORMATION

J13: Swarm produced

Table 79: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Swarm produced*)

NONE	1 - 5 SWARM(S) PRODUCED	6 - 10 SWARMS PRODUCED	MORE THAN 10 SWARMS PRODUCED	NO INFORMATION	winter mortality
	0.94	0.08	0.03	4×10^{-6}	NONE
		0.11	0.06	2×10^{-5}	1 - 5 SWARM(S) PRODUCED
			0.94	1×10^{-6}	6 - 10 SWARMS PRODUCED
				$< 10^{-7}$	MORE THAN 10 SWARMS PRODUCED
					NO INFORMATION

Table 80: Pairwise comparisons fo the seasonal mortality of EPILOBEE *first* year (variable *Swarm produced*)

NONE	1 - 5 SWARM(S) PRODUCED	6 - 10 SWARMS PRODUCED	MORE THAN 10 SWARMS PRODUCED	NO INFORMATION	seasonal mortality
	0.15	0.11	0.74	0.04	NONE
		0.64	0.27	1×10^{-3}	1 - 5 SWARM(S) PRODUCED
			0.17	4×10^{-3}	6 - 10 SWARMS PRODUCED
				0.02	MORE THAN 10 SWARMS PRODUCED
					NO INFORMATION

Table 81: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Swarm produced*)

NONE	1 - 5 SWARM(S) PRODUCED	6 - 10 SWARMS PRODUCED	MORE THAN 10 SWARMS PRODUCED	NO INFORMATION	winter mortality
	0.03	0.78	0.61	0.80	NONE
		0.30	0.04	0.08	1 - 5 SWARM(S) PRODUCED
			0.56	0.91	6 - 10 SWARMS PRODUCED
				0.51	MORE THAN 10 SWARMS PRODUCED
					NO INFORMATION

Table 82: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Swarm produced*)

NONE	1 - 5 SWARM(S) PRODUCED	6 - 10 SWARMS PRODUCED	MORE THAN 10 SWARMS PRODUCED	NO INFORMATION	seasonal mortality
	0.90	0.88	0.62	0.57	NONE
		0.83	0.59	0.72	1 - 5 SWARM(S) PRODUCED
			0.85	0.62	6 - 10 SWARMS PRODUCED
				0.36	MORE THAN 10 SWARMS PRODUCED
					NO INFORMATION

J14: Production of the beekeeper

Table 83: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Production*)

ONLY HONEY	INCLUDES POLLEN PRODUCTION	INCLUDES POLLINATION SERVICES	INCLUDES QUEENS PRODUCTION	INCLUDES ROYAL JELLY PRODUCTION	INCLUDES SWARM PRODUCTION	OTHER	winter mortality
	0.21	0.65	0.41	0.14	0.06	3×10^{-3}	ONLY HONEY
		0.32	0.91	0.29	0.55	0.14	INCLUDES POLLEN PRODUCTION
			0.37	0.13	0.17	0.06	INCLUDES POLLINATION SERVICES
				0.37	0.76	0.35	INCLUDES QUEENS PRODUCTION
					0.43	0.68	INCLUDES ROYAL JELLY PRODUCTION
						0.39	INCLUDES SWARM PRODUCTION
							OTHER

Table 84: Pairwise comparisons for the seasonal mortality of EPILOBEE *first* year (variable *Production*)

ONLY HONEY	INCLUDES POLLEN PRODUCTION	INCLUDES POLLINATION SERVICES	INCLUDES QUEENS PRODUCTION	INCLUDES ROYAL JELLY PRODUCTION	INCLUDES SWARM PRODUCTION	OTHER	seasonal mortality
	0.52	0.30	0.20	0.68	0.56	0.99	ONLY HONEY
		0.40	0.14	0.85	0.36	0.63	INCLUDES POLLEN PRODUCTION
			0.16	0.57	0.25	0.31	INCLUDES POLLINATION SERVICES
				0.36	0.46	0.28	INCLUDES QUEENS PRODUCTION
					0.57	0.70	INCLUDES ROYAL JELLY PRODUCTION
						0.66	INCLUDES SWARM PRODUCTION
							OTHER

Table 85: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *Production*)

ONLY HONEY	INCLUDES POLLEN PRODUCTION	INCLUDES POLLINATION SERVICES	INCLUDES QUEENS PRODUCTION	INCLUDES SWARM PRODUCTION	OTHER	winter mortality
	2×10^{-3}	0.63	0.24	0.02	0.22	ONLY HONEY
		0.22	0.43	0.52	0.14	INCLUDES POLLEN PRODUCTION
			0.66	0.43	0.84	INCLUDES POLLINATION SERVICES
				0.77	0.72	INCLUDES QUEENS PRODUCTION
					0.39	INCLUDES SWARM PRODUCTION
						OTHER

Table 86: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Production*)

ONLY HONEY	INCLUDES POLLEN PRODUCTION	INCLUDES POLLINATION SERVICES	INCLUDES QUEENS PRODUCTION	INCLUDES SWARM PRODUCTION	OTHER	winter mortality
	0.06	0.17	0.13	0.36	0.54	ONLY HONEY
		0.02	0.61	0.34	0.26	INCLUDES POLLEN PRODUCTION
			0.04	0.09	0.13	INCLUDES POLLINATION SERVICES
				0.29	0.24	INCLUDES QUEENS PRODUCTION
					0.83	INCLUDES SWARM PRODUCTION
						OTHER

J15: Environment targeted during the previous seasonal migration

Table 87: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *MidSeason_Target*)

CROPS	DIVERSE	NO INFORMATION	OTHER	WILDFLOWERS	winter mortality
	0.77	0.06	0.50	0.60	CROPS
		0.06	0.66	0.38	DIVERSE
			0.20	0.01	NO INFORMATION
				0.22	OTHER
					WILDFLOWERS

Table 88: Pairwise comparisons for the winter mortality of EPILOBEE *second* year (variable *MidSeason_Target*)

CROPS	DIVERSE	NO INFORMATION	OTHER	WILDFLOWERS	winter mortality
	0.39	0.86	0.43	0.18	CROPS
		0.14	0.10	0.49	DIVERSE
			0.37	0.07	NO INFORMATION
				0.04	OTHER
					WILDFLOWERS

J16: Previouswinter mortality

Table 89: Pairwise comparisons for the winter mortality of EPILOBEE *first* year (variable *Winter_mortality_class*)

NO MORTALITY	1 - 5 %	6 - 10 %	11 - 20 %	21 - 50 %	MORE THAN 50%	seasonal mortality
	0.23	0.66	0.85	1×10^{-6}	0.02	NO MORTALITY
		0.30	0.22	0.05	0.08	1 - 5 %
			0.62	1×10^{-3}	0.06	6 - 10 %
				1×10^{-3}	0.08	11 - 20 %
					0.37	21 - 50 %
						MORE THAN 50%

Table 90: Pairwise comparisons for the seasonal mortality of EPILOBEE *second* year (variable *Winter_mortality_class*)

NO MORTALITY	1 - 5 %	6 - 10 %	11 - 20 %	21 - 50 %	MORE THAN 50%	seasonal mortality
	0.90	1×10^{-3}	1×10^{-6}	$< 10^{-6}$	1×10^{-6}	NO MORTALITY
		0.23	0.15	0.07	0.11	1 - 5 %
			0.60	0.17	0.39	6 - 10 %
				0.29	0.57	11 - 20 %
					0.99	21 - 50 %
						MORE THAN 50%

Appendix K – Overall study: selection of the explanatory variables mainly related to the winter and seasonal mortalities

K1: Winter mortality

In this appendix, the threshod 0.20 was used. The following p-values were obtained taking into account the winter mortality as response variable.

When the variable was selected for the rest of the statistical analysis (*i.e.* p-value < 0.20), the cell was **colored in yellow**. When the variable was excluded from the rest of the statistical analysis (*i.e.* p-value > 0.20), the cell was **colored in white**.

Variables	p-value	decision
Age	1×10^{-3}	selected
Activity	1×10^{-13}	selected
Beekeep_for	1×10^{-3}	selected
Qualif	0.01	selected
Training	0.01	selected
Coop_treat	1×10^{-4}	selected
Bee_population_size	1×10^{-16}	selected
Country	1×10^{-59}	selected
Apiary_Size	1×10^{-35}	selected
Production	1×10^{-4}	selected
Apiarist book	1×10^{-5}	selected
Org_member	1×10^{-3}	selected
Continue	0.67	NS
Breed	1×10^{-11}	selected
Chronic_Depop	1×10^{-4}	selected
ClinSign_Brood	1×10^{-3}	selected
ClinSign_Honeybees	1×10^{-6}	selected
H_rate_ColMortality	1×10^{-35}	selected
H_rate_HoneyMortality	0.07	selected
Other_Event	1×10^{-3}	selected
VarroaMites	1×10^{-4}	selected
QueenProblems	1×10^{-8}	selected
Management	1×10^{-15}	selected
Swarm_bought	1×10^{-25}	selected
Swarm_produced	1×10^{-15}	selected
Queen_bought	1×10^{-16}	selected
Queen_produced	1×10^{-18}	selected
MidSeason_Target	1×10^{-3}	selected
Environment	0.02	selected
AmericanFoulbroodV1	1×10^{-13}	selected
AmericanFoulbroodV2	-	-
EuropeanFoulbroodV1	0.21	NS
EuropeanFoulbroodV2	-	-
VarroosisV1	1×10^{-13}	selected
VarroosisV2	-	-
NosemosisV1	0.51	NS
NosemosisV2	-	-
ChronicParalysisV1	0.84	NS
ChronicParalysisV2	-	-
Migration	1×10^{-4}	selected
Merger	1×10^{-5}	selected
Winter_mortality_class	-	-
Program	1×10^{-37}	selected

NS : not selected

K2: Seasonal mortality

In this appendix, the threshod 0.20 was used. The following p-values were obtained taking into account the seasonal mortality as response variable.

When the variable was selected for the rest of the statistical analysis (*i.e.* p-value < 0.20), the cell was **colored in yellow**. When the variable was excluded from the rest of the statistical analysis (*i.e.* p-value > 0.20), the cell was **colored in white**.

Variables	p-value	decision
Age	0.05	selected
Activity	0.16	selected
Beekeep_for	0.88	NS
Qualif	0.54	NS
Training	0.01	selected
Coop_treat	1×10^{-5}	selected
Bee_population_size	1×10^{-3}	selected
Country	1×10^{-43}	selected
Apiary_Size	1×10^{-8}	selected
Production	0.61	NS
Apiarist book	0.04	selected
Org_member	0.74	NS
Continue	0.98	NS
Breed	1×10^{-9}	selected
Chronic_Depop	1×10^{-5}	selected
ClinSign_Brood	1×10^{-12}	selected
ClinSign_Honeybees	1×10^{-5}	selected
H_rate_ColMortality	1×10^{-15}	selected
H_rate_HoneyMortality	1×10^{-8}	selected
Other_Event	1×10^{-3}	selected
VarroaMites	0.92	NS
QueenProblems	1×10^{-11}	selected
Management	1×10^{-4}	selected
Swarm_bought	1×10^{-3}	selected
Swarm_produced	0.02	selected
Queen_bought	1×10^{-4}	selected
Queen_produced	1×10^{-5}	selected
MidSeason_Target	-	-
Environment	0.23	NS
AmericanFoulbroodV1	-	-
AmericanFoulbroodV2	1×10^{-5}	selected
EuropeanFoulbroodV1	-	-
EuropeanFoulbroodV2	1×10^{-7}	selected
VarroosisV1	-	-
VarroosisV2	1×10^{-3}	selected
NosemosisV1	-	-
NosemosisV2	0.37	NS
ChronicParalysisV1	-	-
ChronicParalysisV2	0.61	NS
Migration	0.30	NS
Merger	1×10^{-6}	selected
Winter_mortality_class	1×10^{-13}	selected
Program	1×10^{-3}	selected

NS : not selected