**Supplementary materials: Beekeepers’ perceptions toward a new omics tool for monitoring bee health in Europe**

Elena Cini1,2\*, Simon G. Potts1, Deepa Senapathi1, Matthias Albrecht3, Karim Arafah4, Dalel Askri4, Michel Bocquet5, Philippe Bulet6, Cecilia Costa7, Pilar De la Rúa8, Alexandra-Maria Klein9, Anina Knauer3, Marika Mänd10, Risto Raimets10, Oliver Schweiger11,12, Jane C. Stout13, Tom D. Breeze1\*

1Centre for Agri-Environmental Research, School of Agriculture, Policy and Development, University of Reading, Reading, England, United Kingdom

2School of Environmental and Natural Sciences, Bangor University, Bangor, Wales, United Kingdom

3Agroecology and Environment, Agroscope, Zurich, Switzerland

4Plateforme BioPark d’Archamps, Archamps, France

5Apimedia, Pringy, Annecy, France

6Institute for Advanced Biosciences, CR Inserm U1209, CNRS UMR5309, Université Grenoble Alpes. Team-Verdel: ARN, Epigénétique et Stress/RNA, Epigenetics and Stress, Grenoble, France

7CREA Research Centre for Agriculture and Environment, Bologna, Italy

8Department of Zoology and Physical Anthropology, Faculty of Veterinary, University of Murcia, Murcia, Spain

9Chair of Nature Conservation and Landscape Ecology, University of Freiburg, Freiburg, Germany

10Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences, Tartu, Estonia

11UFZ – Helmholtz Centre for Environmental Research, Department of Community Ecology, Halle, Germany

12German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Deutscher, Leipzig, Germany

13Trinity College Dublin, School of Natural Sciences, Botany Department, College Green, Dublin, Ireland

\*Corresponding authors

Emails: [elena.cini.ec@gmail.com](mailto:elena.cini.ec@gmail.com) (EC), [t.d.breeze@reading.ac.uk](mailto:t.d.breeze@reading.ac.uk) (TB)

**S6 Appendix. Cost of using and managing the Bee Health Card**

|  |  |
| --- | --- |
| Table A. Costs of using the BHC tool per use (assuming 10 samples/use). | |
| Cost type | **Cost/use** |
| Beekeeper consumable costs per use | €2.24 |
| Postage costs | €8.95-€32.03 |
| Lab consumable costs per use | €15.54 |
| Staff costs per use | €6.69-€14.97 |
| Data storage per use (~2.5MB) | €0.001 |
| Total costs/use | **€33.83 (ESP) – €45.66 (DEU)** |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table B. Total national running costs of the BHC under high rates of adoption. | | | | | | | | | |
| Country | **N° beekeepers** | **Adoption rate1** | **Samples per year2** | **BK fixed costs3**  **(€,000)** | **BK variable costs4**  **(€,000)** | **Postage costs5**  **(€,000)** | **Analytical costs6**  **(€,000)** | **Admin costs7**  **(€,000)** | **Total costs**  **(€,000)** |
| Estonia | 5,215 | 97% | 50,481 | € 8 | € 4 | € 46 | € 45 | € 29 | € 133 |
| Germany | 116,000 | 73% | 843,320 | € 226 | € 118 | € 1,676 | € 1,443 | € 61 | € 3,535 |
| Ireland | 3,300 | 94% | 30,888 | € 7 | € 4 | € 42 | € 43 | € 53 | € 141 |
| Italy | 56,059 | 94% | 526,955 | € 109 | € 57 | € 518 | € 685 | € 59 | € 1,338 |
| Spain | 28,786 | 90% | 259,074 | € 68 | € 35 | € 298 | € 352 | € 49 | € 802 |
| Switzerland | 18,150 | 81% | 146,652 | € 36 | € 19 | € 182 | € 256 | € 41 | € 534 |
| UK | 39,475 | 90% | 357,173 | € 79 | € 41 | € 164 | € 558 | € 41 | € 883 |
| 1Rate of adoption among beekeepers when the BHC is provided with economic incentives and with no extra costs. 2Number of samples to be process, assuming each user sends in 10 samples (figures rounded to the nearest 10). 3Cost of reusable materials each beekeeper must use. 4Costs of materials that are consumed with each use of the health card. 5Costs of postage using half standard international carrier rates. 6Costs associated with lab work per sample analysed. 7Salary of an administrator. | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table C. Total national running costs of the BHC under low rates of adoption. | | | | | | | | | |
| Country | **N° beekeepers** | **Adoption rate1** | **Samples per year2** | **BK fixed costs3 (€,000)** | **BK variable costs4 (€,000)** | **Postage costs5 (€,000)** | **Analytical costs6 (€,000)** | **Admin costs7 (€,000)** | **Total costs (€,000)** |
| Estonia | 5,215 | 34% | 50,480 | € 8 | € 4 | € 47 | € 28 | € 29 | € 115 |
| Germany | 116,000 | 45% | 843,320 | € 226 | € 118 | € 1,687 | € 818 | € 61 | € 2,909 |
| Ireland | 3,300 | 50% | 30,890 | € 7 | € 4 | € 42 | € 25 | € 53 | € 131 |
| Italy | 56,059 | 45% | 526,960 | € 109 | € 57 | € 517 | € 395 | € 59 | € 1,138 |
| Spain | 28,786 | 55% | 259,070 | € 68 | € 35 | € 297 | € 246 | € 49 | € 694 |
| Switzerland | 18,150 | 46% | 146,650 | € 36 | € 19 | € 183 | € 130 | € 41 | € 408 |
| UK | 39,475 | 46% | 357,170 | € 79 | € 41 | € 164 | € 284 | € 41 | € 609 |
| 1Rate of adoption among beekeepers when the BHC is provided with no economic incentives and with extra costs. 2Number of samples to be process, assuming each user sends in 10 samples (figures rounded to the nearest 10). 3Cost of reusable materials each beekeeper must use. 4Costs of materials that are consumed with each use of the health card. 5Costs of postage using half standard international carrier rates. 6Costs associated with lab work per sample analysed. 7Salary of an administrator. | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table D. Projected impacts on winter colony losses under a pessimistic efficiency frontier. | | | | | | | | | |
|  |  |  |  |  |  | **% Increase in survival6** | | **Extra colonies surviving7** | |
| Country | **Total colonies1** | **Winter loss2** | **Losses3 (status Quo)** | **Adoption (high)4** | **Adoption (low)5** | **High Ad** | **Low Ad** | **High Ad** | **Low Ad** |
| Estonia | 48,720 | 8.30% | 4,044 | 97% | 34% | 47% | 6% | 1,895 | 239 |
| Germany | 771,850 | 11.60% | 89,535 | 73% | 45% | 26% | 10% | 23,661 | 9,227 |
| Ireland | 22278 | 3.90% | 869 | 94% | 50% | 44% | 12% | 381 | 107 |
| Italy | 423,144 | 8.80% | 37,237 | 94% | 45% | 44% | 10% | 16,451 | 3,838 |
| Spain | 2,901,680 | 17.60% | 510,696 | 90% | 55% | 41% | 15% | 206,832 | 77,243 |
| Switzerland | 179,473 | 7.40% | 13,281 | 81% | 46% | 33% | 11% | 4,335 | 1,417 |
| UK | 255,000 | 5.40% | 13,770 | 90% | 46% | 41% | 11% | 5,636 | 1,476 |
| 1Total estimated colony numbers from FAOSTAT, 2022, NBU, 2022 (GBR) and EC, 2021c (IRE). 2Percentage of winter colony losses as reported in Gray et al., 2020. 3Number of colonies projected to be lost with no intervention. 4Rate of adoption among beekeepers when the BHC is provided with economic incentives and with no extra costs. 5Rate of adoption among beekeepers when the BHC is provided with no economic incentives and with extra costs. 6Percentage of reduction in colony losses thanks to the BHC, based on a maximum 50% with total adoption. 7Number of colonies that survive thanks to the BHC. | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table E. Projected impacts on winter colony losses under a linear efficiency frontier. | | | | | | | | | |
|  |  |  |  |  |  | **% Increase in survival6** | | **Extra colonies surviving7** | |
| Country | **Total colonies1** | **Winter loss2** | **Losses (status Quo)3** | **Adoption (high)4** | **Adoption (low)5** | **High Ad** | **Low Ad** | **High Ad** | **Low Ad** |
| Estonia | 48,720 | 8.30% | 4,044 | 97% | 34% | 50% | 28% | 2,020 | 1,152 |
| Germany | 771,850 | 11.60% | 89,535 | 73% | 45% | 46% | 35% | 41,431 | 31,421 |
| Ireland | 22278 | 3.90% | 869 | 94% | 50% | 50% | 37% | 433 | 324 |
| Italy | 423,144 | 8.80% | 37,237 | 94% | 45% | 50% | 35% | 18,551 | 13,068 |
| Spain | 2,901,680 | 17.60% | 510,696 | 90% | 55% | 50% | 40% | 252,794 | 203,640 |
| Switzerland | 179,473 | 7.40% | 13,281 | 81% | 46% | 48% | 36% | 6,396 | 4,718 |
| UK | 255,000 | 5.40% | 13,770 | 90% | 46% | 50% | 36% | 6,823 | 4,900 |
| 1Total estimated colony numbers from FAOSTAT, 2022, NBU, 2022 (GBR) and EC, 2021c (IRE). 2Percentage of winter colony losses as reported in Gray et al., 2020. 3Number of colonies projected to be lost with no intervention. 4Rate of adoption among beekeepers when the BHC is provided with economic incentives and with no extra costs. 5Rate of adoption among beekeepers when the BHC is provided with no economic incentives and with extra costs. 6Percentage of reduction in colony losses thanks to the BHC, based on a maximum 50% with total adoption. 7Number of colonies that survive thanks to the BHC. | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table F. Projected impacts on winter colony losses under the optimistic efficiency frontier. | | | | | | | | | |
|  |  |  |  |  |  | **% Increase in survival6** | | **Extra colonies surviving7** | |
| Country | **Total colonies1** | **Winter loss2** | **Losses (status Quo)3** | **Adoption (high)4** | **Adoption (low)5** | **High Ad** | **Low Ad** | **High Ad** | **Low Ad** |
| Estonia | 48,720 | 8.30% | 4,044 | 97% | 34% | 97% | 34% | 3,914 | 1,391 |
| Germany | 771,850 | 11.60% | 89,535 | 73% | 45% | 73% | 45% | 65,092 | 40,649 |
| Ireland | 22278 | 3.90% | 869 | 94% | 50% | 94% | 50% | 813 | 431 |
| Italy | 423,144 | 8.80% | 37,237 | 94% | 45% | 94% | 45% | 35,002 | 16,905 |
| Spain | 2,901,680 | 17.60% | 510,696 | 90% | 55% | 90% | 55% | 459,626 | 280,883 |
| Switzerland | 179,473 | 7.40% | 13,281 | 81% | 46% | 81% | 46% | 10,731 | 6,136 |
| UK | 255,000 | 5.40% | 13,770 | 90% | 46% | 90% | 46% | 12,459 | 6,376 |
| 1Total estimated colony numbers from FAOSTAT, 2022, NBU, 2022 (GBR) and EC, 2021c (IRE). 2Percentage of winter colony losses as reported in Gray et al., 2020. 3Number of colonies projected to be lost with no intervention. 4Rate of adoption among beekeepers when the BHC is provided with economic incentives and with no extra costs. 5Rate of adoption among beekeepers when the BHC is provided with no economic incentives and with extra costs. 6Percentage of reduction in colony losses thanks to the BHC, based on a maximum 50% with total adoption. 7Number of colonies that survive thanks to the BHC. | | | | | | | | | |