

Supplementary Document S1. Partner organisations and their roles in the PoshBee 2019 field study

Country	Field work teams	Growers / Beekeepers organisations	Chemical analysis	Pathogen analysis	Nutrition/ Palynology	Performance measures
CHE	Agroscope	Apisuisse	-	-	-	-
ESP	Universidad de Murcia	ASAJA	-	-	-	-
EST	EMU	-	-	-	-	-
GBR	University of Reading	NFU BBKA	-	-	-	-
GER	U.Freiburg UFZ	Bauernverband Sachsen-Anhalt e.V. Imkerei Bördebiene Imkerverband Sachsen-Anhalt e.V	-	-	-	Gut microbiota UFZ
IRL	Trinity Collge Dublin	TEAGASC FIBKA	-	-	-	-
ITA	CREA-AA	Coldiretti UNAAPI	Bee specimens Bees wax Royal Jelly CREA-AA	-	Pollen stores / palynology CREA-AA	-
SWE	U. Lund SLU	LRF	-	-	-	-
HUN	-	-	Crop pollen / Pollen from <i>Apis</i> traps NÉBIH	-	-	-
POL	-	-	Pollen stores / Pesticide residues & metals PIWET	-	-	-
BEL	-	-	-	-	Pollen stores / Nutrition / fat body UMONS	Bee specimens /Wing asymmetry UMONS
FRA	-	-	Stomach nectar Anses Sophia Antipolis Metals Anses Maisons-Alfort	Bee specimens Anses Sophia Antipolis and Anses Maisons- Alfort	-	Haemolymph proteomics CNRS & BioPark d'Archamps

Supplementary Document S2. Summary of measurements and samples obtained during PoshBee field study. iw - internal workers; fw - foraging workers; f - females; Numbers/quantities given generally refer to minimum requirements per site; * Field protocol numbers refer to the handbook of methodological protocols (see Hodge & Stout 2019 for details)

	Field measurements	Field samples for subsequent laboratory analysis	Field protocol nos.*
Habitat/ Landscape	Crop data Field boundary EUNIS codes Adjacent field EUNIS codes Field boundary floral survey Wild pollinator surveys x 3 Farmer surveys		1.1.3 1.3.1 1.3.1 1.3.3 1.3.4 1.3.5
Pests & diseases	<u>Apis</u> <i>Varroa</i> Small hive beetle Asian hornet Chalkbrood American foulbrood European foulbrood Deformed wing <u>Bombus</u> Wax moth Mould Other inverts. <u>Osmia</u> Natural enemies	<i>Apis</i> pathogen pre-screen (60 iw) <i>Apis</i> pathogen final (60 iw) <i>Bombus</i> pathogen pre-screen (12 iw) <i>Bombus</i> pathogen final (30 iw) <i>Osmia</i> pathogen pre-screen (10 f) <i>Osmia</i> pathogen final (15 f)	1.5.2 1.5.3 1.5.4 1.5.5 1.5.6 1.5.7 1.5.8 1.5.9 1.5.10 1.4.4
Chemicals		Pollen from crop (1000 blossoms) Pollen from <i>Apis</i> pollen traps (5 g) Pollen from foraging <i>Bombus</i> <i>Apis</i> - metals analysis (90 fw) <i>Apis</i> - agrochemicals (60 fw) <i>Bombus</i> - agrochemicals (30 fw) <i>Osmia</i> agrochemicals (18 ff) Nectar from <i>Apis</i> stomachs (1 mL) Nectar from <i>Bombus</i> stomachs (1 mL) <i>Apis</i> bee bread (12 g) <i>Bombus</i> pollen stores (12 g) <i>Osmia</i> pollen stores (12 g)	1.4.2 1.4.4 1.4.3 1.4.5
Nutrition & palynology		Flower samples for pollen library <i>Apis</i> beebread (3.1 g) <i>Bombus</i> pollen stores (3.1 g) <i>Osmia</i> pollen stores (3.1 g)	1.3.3 1.4.5
General performance	<i>Apis</i> colony Evaluation x 2 <i>Bombus</i> colony weights x 3 <i>Bombus</i> caste counts <i>Osmia</i> occupied tubes <i>Osmia</i> emergence success	<i>Apis</i> haemolymph (15 fw) <i>Bombus</i> haemolymph (5 fw) <i>Apis</i> gut microbiota (10 fw) <i>Bombus</i> gut microbiota (5 fw) <i>Apis</i> wing asymmetry (60 iw) <i>Bombus</i> wing asymmetry (30 iw)	1.5.1 1.5.9 1.5.9 1.5.10 1.5.10 1.6.1 1.6.2 1.6.2

Supplementary Document S3: Summary of *Apis mellifera* colony set up in each partner country of the PoshBee 2019 field investigation.

Country	<i>Apis mellifera</i> Sub-species	Hive type	Primary hive material	Dimensions brood frame (cm)	Dimensions super frame (cm)	Primary Varroa treatment
CHE	<i>A. m. carnica</i>	Swiss national format	Polystyrene	34.5 x 26.5	34.5 x 26.5	Oxalic acid
ESP	<i>A. m. iberiensis</i>	Langstroth	Wood	42 x 20	42 x 20	Amicel varroa
EST	<i>A. m. ligustica</i>	Langstroth/ Farrar	Polystyrene/ Wood	48 x 23	48 x 23	Oxalic acid
GBR	APP: <i>A. m.</i> mixed OSR: <i>A. m. buckfast</i>	APP: British Standard National OSR: Nucleus	APP: Wood OSR: Polystyrene	APP: 35.5 x 21.6 OSR:	APP: 35.5 x 21.6 OSR:	Apitraz
GER	APP: <i>A. m. carnica</i> OSR: <i>A. m. mellifera</i>	APP: Zander OSR:	APP: Wood OSR: Polystyrene	APP: 40 x 20 OSR:	APP: 40 x 20 OSR:	APP: Oxalic acid OSR: Oxalsäure
IRL	<i>A. m. mellifera</i>	Swienty	Polystyrene	34.5 x 19	33.5 x 11.5	Apivar
ITA	<i>A. m. ligustica</i>	Dadant	Wood	47 x 30	47 X 15	Oxalic acid
SWE	<i>A. m.</i> mixed	Låg Normal	Polystyrene	36.6 x 22.2	36.6 x 22.2	Apistan

Supplementary Document S4. Suppliers of commercial *Bombus terrestris* colonies for each partner country of the 2019 PoshBee field study

Country	Supplier
CHE	Andermatt Biocontrol AG, Switzerland
ESP	ControlBio, Spain
EST	AM Azoli, Latvia
GBR	Agralan, UK
GER	Katzbiotech, Germany
IRL	Agralan, UK
ITA	Bioplanet, Italy
SWE	Biobasiq, Sweden

Supplementary Document S5. Descriptions and summary of PoshBee 2019 Field Study Site Network

For location of sites, see Figure 2 in main text. In some countries, the two study crops (OSR and apples) were grown in distinct regions. For example, in Spain, the OSR sites were in the province of Albacete, while the APP sites were in Murcia. In the UK, although all sites were in the south-east of England, the apples were clustered in the county of Kent, whereas the OSR sites were situated in the adjacent counties of Oxfordshire and Berkshire. The Italian apple sites were in the mountainous northern region of Trentino, whereas the OSR fields were in the region of Piedmont, and the German OSR fields were in the region of Saxony-Anhalt, while the apple orchards were 400 km south in the region of Baden, near to the Swiss border. All the study sites in Switzerland were located in the canton of Zürich, in the north-eastern part of the country, the Swedish sites were located in the extreme south of the country in the plains of Scania, and the Estonian sites were located in the counties of Tartu and Viljandi in the vicinity of the lake Võrtsjärv. There was no clustering of the Irish sites, which were spread over the east of the country and ranged from close to the border with Northern Ireland to County Waterford in the south.

For the OSR crops, the mean distances between sites ranged from 19 km in Switzerland to 62 km in Ireland, and the mean nearest neighbour distances ranged from 6 km in Italy to 18 km in Germany. For the apple orchards, the sites used in Germany were all relatively close to one another, with a mean separation of 10 km and a maximum distance apart of 21 km. This contrasted with the Irish apple orchards which were on average 104 km apart with the maximum distance between two sites being 203 km. The mean nearest neighbour distances for apples ranged from 5 km in Germany to 27 km in Ireland. In terms of the minimum inter-site distance, only in one case, for two apple orchards in Spain, were two sites of the same crop closer than 3 km.

The areas of the fields used as study sites also varied considerably among partners. For OSR, the smallest fields were in Switzerland (mean 2.3 ha) and Italy (4.3 ha) and the largest fields were in Germany (51 ha) and Estonia (40.5 ha). Similarly, the apple orchards ranged widely in size, from the smallest site in Spain with an area of 0.3 ha to the largest orchard in Sweden which, at 45 ha, was 140 times larger. On average, Italy (mean \approx 1 ha) and Switzerland (\approx 2 ha) had the smallest apple orchards, and Sweden (15.8 ha) and Estonia (11.7 ha) the largest.

Nearly 40 different varieties of OSR were grown over the 64 study sites, and although most were country-specific, some varieties were grown in two or more countries (e.g. Arsenal, Attletick, Exception, Exhalte, Vistive). Most OSR was sown at densities of around 40-60 stems per m², although the OSR crops in Switzerland were sown at a much lower density, 6-19 stems per m². The UK provided no data on crop density, whereas Spain and Italy reported recommended sowing rates and did not measure stem density directly.

The apple varieties recorded reflected the climate in the areas where they were being grown, with only a few varieties (e.g. Gala, Discovery, Jonagored) being found in more than one country. The Italian and English orchards tended to grow only one or two varieties of apples, whereas typically, across other countries, around 5 varieties were present. The orchards in Estonia had extremely high apple diversity, with one orchard growing over 100 varieties. Most of the orchards had tree heights of around 2-3m tall so that apples could be hand-picked. There were some exceptions, for example one orchard in Italy had trees of up to 4.5 m tall one and old orchard (> 100 yrs) in Ireland where trees were over 6 m. The typical conventional orchards were planted with densities of around 3-4000 trees per ha. The Estonian orchards had slightly lower tree densities than other countries, with 400-1000 trees per ha. Some orchards did have much lower tree densities, for example one site in Sweden had 250 trees per ha and one site in Ireland had 119 trees per ha.

Summary of characteristics of OSR sites in each partner country of the PoshBee 2019 field study.

Country	Varieties	Area (ha)	Stem density (m ⁻²)	Important Dates	Inter-site distances (km)	Nearest neighbour (km)
		Mean Min. Max.	Mean Min. Max.	Crop sown Flowering start Flowering end	Mean Min. Max.	Mean Min. Max.
CHE	Avatar, Attletick,	2.3	11	09.09.18	19	9
	Trezzor, Vistive,	1.0	6	16.04.19	7	7
	V310OL, V3160	5.5	19	23.05.19	35	13
ESP	Alvaro, DK Expansion,	23.6	40	03.10.18	20	10
	DK Exception, DK	7.0	40	10.04.19	8	8
	Platinum, Feliciano	40.0	40	30.05.19	36	12
EST	KWS, Hillico,	40.5	53	12.08.18	58	10
	Miranda, Umberto	7.4	40	14.05.19	5	5
	DK 7175 CL,	129.5	75	02.06.19	100	37
GBR	DK Seax,					
	Legato,					
	Mentor					
GBR	Barbados, Campus			-----	30	15
	conventional, Crome,			10.4.19	9	9
	Elgar, Flamingo,			31.5.19	58	26
GER	Impressario					
	Arabella, Arsenal,	51.0	53	23.08.18	49	18
	Attletick, Bender,	10.0	45	15.04.19	15	15
GER	Exception, Florida,	135.0	60	05.06.19	77	25
	Hattrick, Penn					
IRL	Exalte	11.1	41	28.08.18	62	9
	Harnas	0.5	23	16.03.19	3	3
		22.0	71	04.06.19	111	25
ITA	Adriana, Arsenal,	4.3	55	18.09.18	20	6
	Atenzo LG,	1.0	55	15.04.19	5	5
	DK Exkio, Sensei	16.4	55	19.05.19	39	9
SWE	Butterfly, Dairot,	10.0	38	18.08.18	50	13
	Exception, Exalte,	3.2	28	-----	6	6
	V316OL HOII hybrid,	15.0	50	-----	97	23
	Vistive,					

Summary of characteristics of apple sites in each partner country of the PoshBee 2019 field study.

Country	Main Varieties	No. of Varieties	Area (ha)	Tree density (m ⁻²)	Tree height (m)	Important Dates	Inter-site distances (km)	Nearest neighbour (km)
		Mean	Mean	Mean	Mean	Flowering start	Mean	Mean
		Min.	Min.	Min.	Min.	Flowering end	Min.	Min.
		Max.	Max.	Max.	Max.		Max	Max
CHE	Gala, Diwa, Cox							
	Orange, Jonagold, Rubinette, Boskop,	6	1.96	2823	2.3	16.04.19	36	11
	Golden Remo, Reanda, Ladina, Boskop	2	0.50	1250	1.5	13.05.19	8	8
ESP	Royal Gala, Pero de alcuza, Golden delicious, Spanish	10	4.50	3333	3.0		69	15
	Green doncella, Brookfield	2	2.36	819	2.6	05.04.19	34	14
		1	0.32	400	2.0	17.05.19	2	2
EST		3	9.20	1100	2.9		81	43
	Antei, Krista	60	11.70	1000	2.5	16.05.19	56	16
		19	1.34	1000	2.5	29.05.19	7	7
GBR		100	40.00	1000	2.5		116	28
	Gala	1	11.24			10.04.19	20	10
		1	2.65			31.05.19	5	5
GER		1	52.12				40	24
	Braeburn, Elstar, Fuji Gala, Jonagold, Jonagored	3	2.47	3255	3.0	18.04.19	10	5
		1	0.62	3125	2.3	05.05.19	4	4
IRL		4	7.55	3333	3.3		21	6
	Bramley, Cox, Discovery, Karmijn, Jonagold, Jonagored	8	2.34	1279	3.2	09.04.19	104	27
		3	0.45	119	2.4	26.05.19	11	11
ITA		20	4.00	3135	6.0		203	62
	Golden delicious	1	0.98	4000	3.6	11.04.19	33	15
		1	0.37	4000	3.0	12.05.19	13	13
SWE		2	2.36	4000	4.5		63	17
	Alice, Aroma, Discovery, Frida, Ingrid Marie, Santana	8	15.81	2550	2.7	08.05.19	38	9
		1	1.50	250	2.3	22.05.19	5	5
		23	45.00	4500	3.0		79	15

Participant Information Form

School of Natural Sciences, Trinity College Dublin

1. Title of study:

PoshBee

(Pan-European Assessment, Monitoring and Mitigation of
Stressors on the Health of Bees)

2. Details: Research staff

Prof Jane Stout - Trinity College Dublin (TCD)
Dr Simon Hodge - TCD
Dr Michael Gaffney - TEAGSC
Ms Eleanor Attridge - Federation of Irish Beekeepers Associations

3. Introduction:

Many of our food crops and wild flowers depend upon pollination by various insects in order to reproduce. Several of these insect pollinators, such as honey bees and bumble bees, currently face multiple threats, such as abnormal weather patterns, habitat loss, invasive pests and diseases, and exposure to agrochemicals. The PoshBee project will collect data on bee performance in Ireland, as well as in another seven European countries, and combine these results with data on land use, nectar and pollen content of flowers, and potential exposure to agrichemicals, to assess which factors pose the greatest risks to bee health and productivity. Ultimately the results will be used to help understand the impacts of these multiple stressors on different bee species, and help develop management practices that reduce negative impacts on bees and promote strategies that positively influence bee performance.

4. Procedures:

We are seeking land owners/ producers/ farm managers who are willing to participate in this study. Participants will allow access to their land (either apple orchards or OSR crops), and permit researchers to install honey bee hives and wild bee nests within these crops. The hives will be maintained by qualified beekeepers for the duration of the project. Researchers will take various measurements related to these insects and the crops during the flowering/ growing season: for example, pollen and nectar content of flowers, honey production, occurrence of bee pests and diseases, abundance of wild bee species in the vicinity of the crops, and concentrations of agrochemicals.

Participants will be interviewed and/ or provided with questionnaires regarding their typical crop management practices, including current and historical use of agrochemicals on these crops and/or at these sites. Although the PoshBee project will run for a total of 5 years, the active field work will last only for one growing season (approximately 7 months). During this time it is envisaged that sites will be visited approximately twice a month.

5. Benefits:

It is envisaged that this project will lead to the identification of environmental or crop management factors that directly or indirectly inhibit or promote the performance of different pollinators in the context of European agriculture. In a wider context, this information will be used in an advisory capacity to help growers conserve and promote the populations of pollinating insects required to maintain crop

yields. Individual participants will benefit by obtaining information on the 'health' of the plants and pollinators in their sites.

6. Risks:

There are no known risks associated with your participation in this study. TCD researchers will be covered by TCD public liability insurance whilst on site (copies of insurance documents can be provided on request).

7. Exclusion from participation:

There are no personal criteria for exclusion associated with this project.

8. Confidentiality:

We will collect and retain only the minimal amount of data required for your participation and it will only be used for the purposes of this study. Your identity will remain confidential. Your name, or any information that could lead to your identification, will not be disclosed to anyone outside the study, will not be made public in any way, and not shared with third parties. All personal data will be stored securely and managed in accordance with current EU Data protection legislation.

9. Voluntary Participation:

We are grateful that you have volunteered to participate in this project. You may choose to leave the project at any time. If you leave the project, you will not be penalized in any way and will not give up any of the benefits associated with the project.

10. Reimbursements:

There are no reimbursements or financial incentives for participants of this study.

11. Stopping the study:

Please be aware that the researchers may stop this project, or stop your participation in the study, at any time without your consent.

12. Permission:

The project has the approval of the Research Ethics Committee of TCD School of Natural Sciences. The project also complies with General Data Protection Regulations required by TCD. Researchers will comply with TCD Health & Safety regulations and conduct appropriate Risk Assessments prior to commencing work.

13. Access to data:

Under the Freedom of Information Act 2014, and to ensure records are accurate and up to date, participants can access the data we hold relevant to their participation in this project at any time.

14. Sharing the results:

The overall research results will be shared with participants before wider publication. Participants may also request to see the results relevant to their own participation.

15. Further information:

More information about the PoshBee project, answers to questions about your participation, expectations and rights, can be obtained from Prof Jane Stout, who can be contacted by:

telephone: +353 1 896 3761 or email: stoutj@tcd.ie

Informed Consent Form

School of Natural Sciences, Trinity College Dublin

Title of research study: **PoshBee**

This study and this consent form have been explained to me. I believe I understand what will happen if I agree to be part of this study.

I have read, or had read to me, this consent form. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction. I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights. I have received a copy of this agreement and I understand that, if there is a sponsoring company, a signed copy will be sent to that sponsor.

Name of sponsor:

PARTICIPANT'S NAME: _____

PARTICIPANT'S SIGNATURE: _____

Date: _____

Date on which the participant was first furnished with this form:

Participants with literacy difficulties:

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely and understands that they have the right to refuse or withdraw from the study at any time.

Print name of witness: _____

Signature of witness: _____

Date (Day/month/year) _____

Statement of investigator's responsibility: I have explained the nature, purpose, procedures, benefits, risks of, or alternatives to, this research study. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

Researcher's signature: _____ **Date:** _____

(Keep the original of this form in the project records, give one copy to the participant, and send one copy to the sponsor (if there is a sponsor)).

Supplementary Document S7. EUNIS codes used for habitat classification of field boundaries surrounding fields of focal crops, and land use category of fields immediately adjacent to focal crop (www.eea.europa.eu/data-and-maps/data/eunis-habitat-classification)

Boundary Feature	Code
No boundary - fields run/ merge into each other	NB
Bare boundary (wire fence; wooden fence; stone wall)	BB
Hedgerow (mixed) / buffer zones / flower strips	FA
Windbreak or monoculture hedge	G5
Woodland edge	E5
Ditch / grassy verge	E2
Habitat	Code
Apples	APP
Oil seed rape	OSR
Pasture/Improved Grassland/	E2
Coniferous woodland	G3
Deciduous woodland	G1
Mixed woodland	G4
Horticulture other than apples	I1.2
Cereals/ arable crops other than OSR	I1.1
Bare tilled arable land	I1.5
Semi-natural habitat/Meadows	SN
Parkland	I2
High density housing / urban	J1
Low density housing / suburban	J2

Supplementary Document S8: Farmer Chemical Use Questionnaire

The survey was written in English and translated into local languages to ensure consistency in answers. All versions were hosted on the survey software Qualtrics via the University of Reading. Different questions were asked to apple and oilseed growers to capture differences in the production systems. These are noted with the prefix (apples) or (oilseed) next to the question number. The questionnaire is presented here but some questions have been abridged for reliability. When answering Question 8b, the respondents were presented with the product names they have provided for Question 8, using the pipe text function in Qualtrics.

Cover letter

Thank you for participating in this study on plant protection methods used in fields that form part of the PoshBee study network. We hope the findings of this survey will enhance our understanding of how plant protection methods affect the health of bees and lead to more definitive advice on their use for farmers and beekeepers across Europe. This study is part of a number of PhD projects conducted by The University of Reading and partners and should take no more than 20mins to complete. This study is funded by the European union's Horizon 2020 research program, and has been designed, administered and all data collected will be analyzed by The University of Reading (UK).

As part of this survey we will ask a few basic demographic questions (e.g. your age, location of your farm etc.) in order to identify trends in perceptions between farmers. Under data protection law, we are required to inform you that the use of the personal data we may hold about you is on the lawful basis of being a public task in the public interest and where it is necessary for scientific or historical research purposes. All of the information collected will be held by the University of Reading (Data controller) and by Qualtrics, the online platform that this survey uses. Both the University of Reading and Qualtrics are fully complicit with EU and UK data protection laws. The data collected in this survey is only intended for use as part of the "Pan-European assessment, monitoring, and mitigation of stressors on the health of bees" (PoshBee), although summarized versions of this data may be made available for later analysis.

Should you wish to withdraw your answers from this survey at any time prior to the publication of results please call Tom Breeze on +44118 378 6419 or e-mail t.d.breeze@reading.ac.uk and quote the questionnaire ID you have been given by the PoshBee team – this number is linked to your responses. If you withdraw from a research study, which processes your personal data, dependent on the stage of withdrawal, we may still rely on this lawful basis to continue using your data if your withdrawal would be of significant detriment to the research study aims.

The survey does not ask for your name, or the address of either you or your farm operations, nor does it collect demographic information. Your individual responses will be held by the University of Reading for the duration of the project and then destroyed. Anonymized summaries of responses from all participants will be retained by the University of Reading indefinitely for use in future work. The data will be stored on a secure drive only accessible to the University of Reading (Dr Tom Breeze) and will not be passed on to any third parties. By participating you are consenting to these terms of data storage and use which have been approved by the University of Reading's Ethics Committee.

You have certain rights under data protection law which are:

- Withdraw your consent, for example if you opted in to be added to a participant register
- Access your personal data or ask for a copy
- Rectify inaccuracies in personal data that we hold about you
- Be forgotten, that is your details removed from systems that we use to process your personal data
- Restrict uses of your data
- Object to uses of your data, for example retention after you have withdrawn from a study

Some restrictions apply to the above rights where data is collected and used for research purposes. You can find out more about your rights on the website of the Information Commissioners Office (ICO) at <https://ico.org.uk> You have a right to complain to the ICO if you are unhappy with how your data has been handled. Please contact the University Data Protection Officer in the first instance at imps@reading.ac.uk, or in writing to: Information Management & Policy Services, University of Reading, Whiteknights, P O Box 217, Reading, RG6 6AH.

Questions

Q1 (All farmers) Approximately how large are the following? (in hectares)

- Your total farming operation
- The area of apples/oilseed you are growing this year
- The area of the field where the PoshBee survey took place

Q2 (Apples) Which maincrop variety(s) of apple did you grow in the orchard where the PoshBee experiment took place?

Q3 (Apples) Which polliniser variety(s) of apple did you grow in the orchard where the PoshBee experiment took place?

Q4 (Apples) How old (in years) is the orchard where the PoshBee Experiment took place?

Q5 (Apples) Which (if any) chemical growth regulators (auxins etc.) did you apply to the orchard where the PoshBee experiment took place?

Q6 Are you involved in any of the following? (please select all that apply)

- Certified Organic farming scheme
- Certified Integrated Pest Management scheme
- Any other form of certification scheme

Q6b Including this year, how many years have you been practicing organic farming in the orchard/field where the PoshBee experiment took place?

Q7 This year, did you use any of the following biological control strategies in the orchard/field where the PoshBee experiment took place? Please tick all that apply

- Encourage natural enemies of crop pests in the orchard/field
- Buy in natural enemies to supplement other pest control measures
- Manual weeding
- Mechanical weeding
- Other biological control

Q8 Since your last harvest, which plant protection products (including herbicides, insecticides, fungicides, soap, copper etc.) did you apply to the orchard/field where the PoshBee experiment will take place? (Respondents could name up to 15 products and give up to three applications)

For each product, please indicate when you apply the product and at what rate are they applied.

	Product name	Date of application	Application rate (l/ha)	Date of application	Application rate (l/ha)	Date of application	Application rate (l/ha)
Product 1							
Product 2							
[...]							
Product 15							

Q8b Which, if any, of these plant protection products did you apply to the orchard/field where the PoshBee experiment took place using a tank mix? Please tick all that apply (answers are piped in form Q8a).

Q9 Finally, is the management in the orchard/field where the PoshBee experiment took place representative of how you manage your other apple orchards?

- Yes, this field is representative
- No, I manage this field differently to my other apple orchards in some way

Q9b Please use this space to describe how it is different from how you manage your other orchards (different plant protection products etc.)

Q10 This year, what was the total yield of the orchard/field where the PoshBee study took place?

Q11 This year, what was the total percentage of class one apples in the orchard where the PoshBee study took place?

Q12: Do you feel that the yield of the orchard/field where the PoshBee study took place was lower than it could have been because it did not have enough pollinators?

- Yes
- No

Q12b How much lower do you think your yields were because of a lack of pollination in the field where the PoshBee survey took place? You may answer in either tonnes/ha or as a percentage of the total yield.

Oilseed Questions:

Q2 (Oilseed) Which variety(s) of oilseed rape did you grow in the field where the PoshBee experiment took place?

Q3 (Oilseed) In the field where the PoshBee experiment took place, which crops did you grow in the following years?

- 2014
- 2015
- 2016
- 2017
- 2018

Q4 (Oilseed) This year, which of the following describes the seeding strategy did you use in the field where the PoshBee experiment took place?

- Sow seeds treated with plant protection products
- Sow untreated seeds

Q5 (Oilseed) Which (if any) plant protection products were these seeds treated with?

Supplementary Document S9. List of the common chemical analytes as agreed in 2019 to be assessed in bee bodies, stomach nectar, pollen from *Apis* traps, beeswax, royal jelly, pollen stores and crop pollen collected during the PoshBee 2019 field study. Primary function or source of analytes in the context of our study: I – insecticide/acaride; F – fungicide; H – herbicide.

Acetamiprid	I	Flutriafol	F
Acrinathrin	I	Glyphosate	H
Alpha-endosulfan	I	Hexythiazox	I
Azinphos-ethyl	I	Imazalil	F
Azinphos-methyl	I	Imidacloprid	I
Azoxystrobin	F	Indoxacarb	I
Beta-Endosulfan	I	Lambda-cyhalothrin	I
Bifenthrin	I	Lindane (gamma-HCH)	I
Boscalid	F	Malathion	I
Bromopropylate	I	Methiocarb	I
Carbendazim	F	Mevinphos	I
Chlorfenvinphos	I	Myclobutanil	F
Chlorpropham	H	Parathion-ethyl	I
Chlorpyrifos-ethyl	I	Parathion-methyl	I
Chlorpyrifos-methyl	I	Pendimethalin	H
Clothianidin	I	Permethrin	I
Coumaphos	I	Phosalone	I
Cyfluthrin	I	Phosmet	I
Cypermethrin	I	Pirimicarb	I
Cyproconazole	F	Pirimiphos-ethyl	I
Cyprodinil	F	Pirimiphos-methyl	I
Deltamethrin	I	Prochloraz	F
Diazinon	I	Profenofos	I
Difenoconazole	F	Pyraclostrobin	F
Dimethoate	I	Pyrazophos	IF
Dimethomorph	F	Pyrimethanil	F
Dimoxystrobin	F	Spiroxamine	F
Dimethylphenyl foramamide	I	Sulfoxaflo	F
Dimethylphenyl methylformamide	I	Tau-fluvalinate	I
Epoxiconazole	F	Tebuconazole	F
Etofenprox	I	Tebufozide	I
Famoxadone	F	Tetraconazole	F
Fenhexamid	F	Tetramethrin	I
Fenitrothion	I	Thiacloprid	I
Fenoxycarb	I	Thiamethoxam	I
Fenpropimorph	F	Thiophanate-methyl	F
Fenthion	I	Triazophos	I
Fenvalerate (esfenvalerate)	I	Trifloxystrobin	F
Fipronil	I	Vinclozolin	F
Fluquinconazole	F		
Flusilazole	F		