

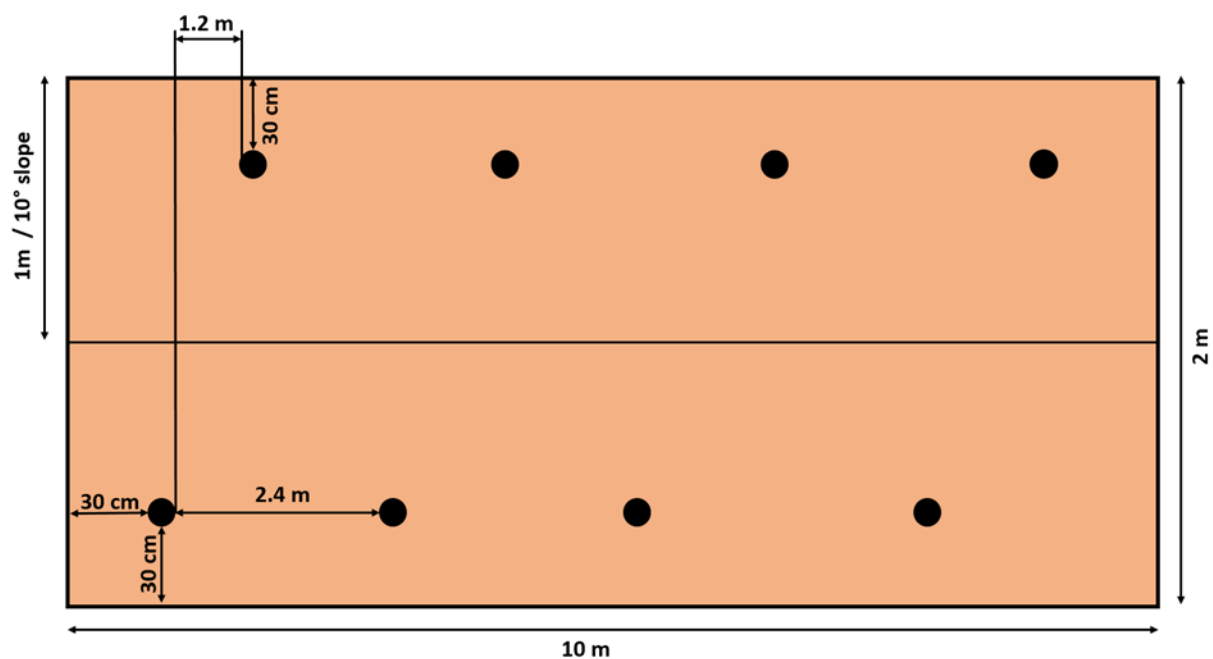
Appendices



Appendix 1: Above: Map of bare ground bee nesting plots at NIAB EMR ($51^{\circ}17'26''N$ $0^{\circ}26'02''E$; QGIS Development Team 2020). Below: Example of nesting areas (plot 8) at the beginning of the study in 2018 with a 10° slope (10 x 1 m) section. The entire plot was 10 x 2 m.

Appendix 2: Surrounding habitat type and dominant local vegetation type of plots. Habitats with perennial grasses contained approximately 10% *Taraxacum officinale*.

Plot	General habitat type	Dominant local vegetation type
1	Field headland adjacent to soil-grown strawberry crops	Perennial grasses, strawberry plants
2	Field headland adjacent to soil-grown strawberry crops	Perennial grasses, strawberry plants
3	Field headland adjacent to apple orchards	Perennial grasses, apple trees
4	Field headland adjacent to a deciduous woodland	Perennial grasses, deciduous trees
5	Field headland adjacent to cherry orchards	Perennial grasses, cherry trees
6	Field headland adjacent to pear orchard	Perennial grasses, pear trees
7	Adjacent to perennial wildflower meadow and a deciduous woodland	Perennial wildflowers, deciduous trees
8	Field headland adjacent to apple orchards	Perennial grasses, apple trees



Appendix 3: Soil sampling method showing the arrangement of soil sampling points (black dots) from the 10 x 2 m bee nesting plots.

Appendix 4: Bee and wasp species sampled from eight study plots in each year of the study at NIAB EMR, Kent, England (51°17'26"N 0°26'02"E) and percentage of species present based on the total records.

Taxon	Family	Year 2018	Year 2019	Year 2020	Years Total	Species %
<i>Andrena haemorrhoa</i> Fabricius	Andrenidae	2	0	0	2	0.2
<i>Andrena nitida</i> Müller	Andrenidae	2	0	0	2	0.2
<i>Andrena scotica</i> Perkins	Andrenidae	5	0	0	5	0.49
<i>Andrena dorsata</i> Kirby	Andrenidae	1	4	1	6	0.59
<i>Andrena florea</i> Fabricius	Andrenidae	0	0	1	1	0.1
<i>Andrena flavipes</i> Panzer	Andrenidae	5	23	3	31	3.04
<i>Andrena minutula</i> Kirby	Andrenidae	2	5	3	10	0.98
<i>Andrena</i> (M)	Andrenidae	0	17	29	46	4.51
<i>Andrena</i> - Medium	Andrenidae	11	0	0	11	1.08
<i>Lasioglossum malachurum</i> Kirby	Halictidae	24	99	74	197	19.3
<i>Lasioglossum malachurum</i> Kirby (M)	Halictidae	0	17	20	37	3.62
<i>Lasioglossum minutissimum</i> Kirby	Halictidae	2	2	7	11	1.08
<i>Lasioglossum pauxillum</i> Schenck	Halictidae	3	0	2	5	0.49
<i>Lasioglossum villosulum</i> Kirby	Halictidae	2	0	0	2	0.2
<i>Lasioglossum morio</i> Fabricius	Halictidae	0	5	3	8	0.78
<i>Lasioglossum leucozonium</i> Schrank	Halictidae	0	1	0	1	0.1
<i>Lasioglossum calceatum</i> Scopoli / <i>Lasioglossum albipes</i> Fabricius	Halictidae	36	11	4	51	5
<i>Lasioglossum</i> - Small	Halictidae	0	0	6	6	0.59
<i>Lasioglossum</i> (M)	Halictidae	0	21	2	23	2.25

Appendix 4 continued

Taxon	Family	Year 2018	Year 2019	Year 2020	Years Total	Species %
<i>Halictus tumulorum</i> Linnaeus	Halictidae	1	1	4	6	0.59
<i>Colletes similis</i> Schenck	Colletidae	0	2	0	2	0.2
<i>Sphecodes</i> - Medium (C)	Halictidae	21	56	40	117	11.5
<i>Sphecodes</i> - Small (C)	Halictidae	0	87	80	167	16.4
<i>Sphecodes monilicornis</i> Kirby (C)	Halictidae	3	15	37	55	5.39
<i>Sphecodes geoffrellus</i> Kirby (C)	Halictidae	0	0	1	1	0.1
<i>Sphecodes longulus</i> von Hagens (C)	Halictidae	0	0	1	1	0.1
<i>Sphecodes puncticeps</i> Thomson (C)	Halictidae	0	0	2	2	0.2
<i>Nomada fabriciana</i> Linnaeus (C)	Apidae	0	0	1	1	0.1
<i>Nomada fucata</i> Panzer (C)	Apidae	2	6	15	23	2.25
<i>Nomada flavoguttata</i> Kirby (C)	Apidae	0	4	10	14	1.37
<i>Nomada zonata</i> Panzer (C)	Apidae	0	1	0	1	0.1
<i>Nomada marshamella</i> Kirby (C)	Apidae	0	0	1	1	0.1
<i>Nomada ruficornis</i> Linnaeus (C)	Apidae	0	0	1	1	0.1
<i>Nomada</i> - Medium (C)	Apidae	0	20	3	23	2.25
<i>Bombylius major</i> Linnaeus (CF)	Bombyliidae	4	13	9	26	2.55
<i>Lindenius albilabris</i> Fabricius (W)	Crabronidae	0	9	4	13	1.27
<i>Lindenius panzeri</i> Vander Linden (W)	Crabronidae	0	0	2	2	0.2
<i>Cerceris rybyensis</i> Linnaeus (W)	Crabronidae	0	7	31	38	3.72
<i>Cerceris quinquefasciata</i> Rossi (W)	Crabronidae	0	0	2	2	0.2

Appendix 4 continued

Taxon	Family	Year 2018	Year 2019	Year 2020	Years Total	Species %
<i>Mimumesa unicolor</i> Vander Linden (W)	Crabronidae	0	1	0	1	0.1
<i>Hedychrum niemelai</i> Linsenmaier (W)	Chrysididae	0	10	23	33	3.23
<i>Vespula germanica</i> Fabricius (W)	Vespidae	0	0	23	23	2.25
<i>Ancistrocerus parietum</i> Linnaeus (W)	Vespidae	0	0	1	1	0.1
<i>Microdynerus exilis</i> Herrich-Schäffer (W)	Vespidae	0	0	2	2	0.2
<i>Tiphia minuta</i> Vander Linden (W)	Tiphiidae	0	1	0	1	0.1
<i>Priocnemis parvula</i> Dahlbom (W)	Pompilidae	0	0	7	7	0.69
Total		126	438	457	1,021	

(C) Kleptoparasitic bee species

(CF) Kleptoparasitic fly species

(W) Wasp species

(M) Males

Sizes (length):

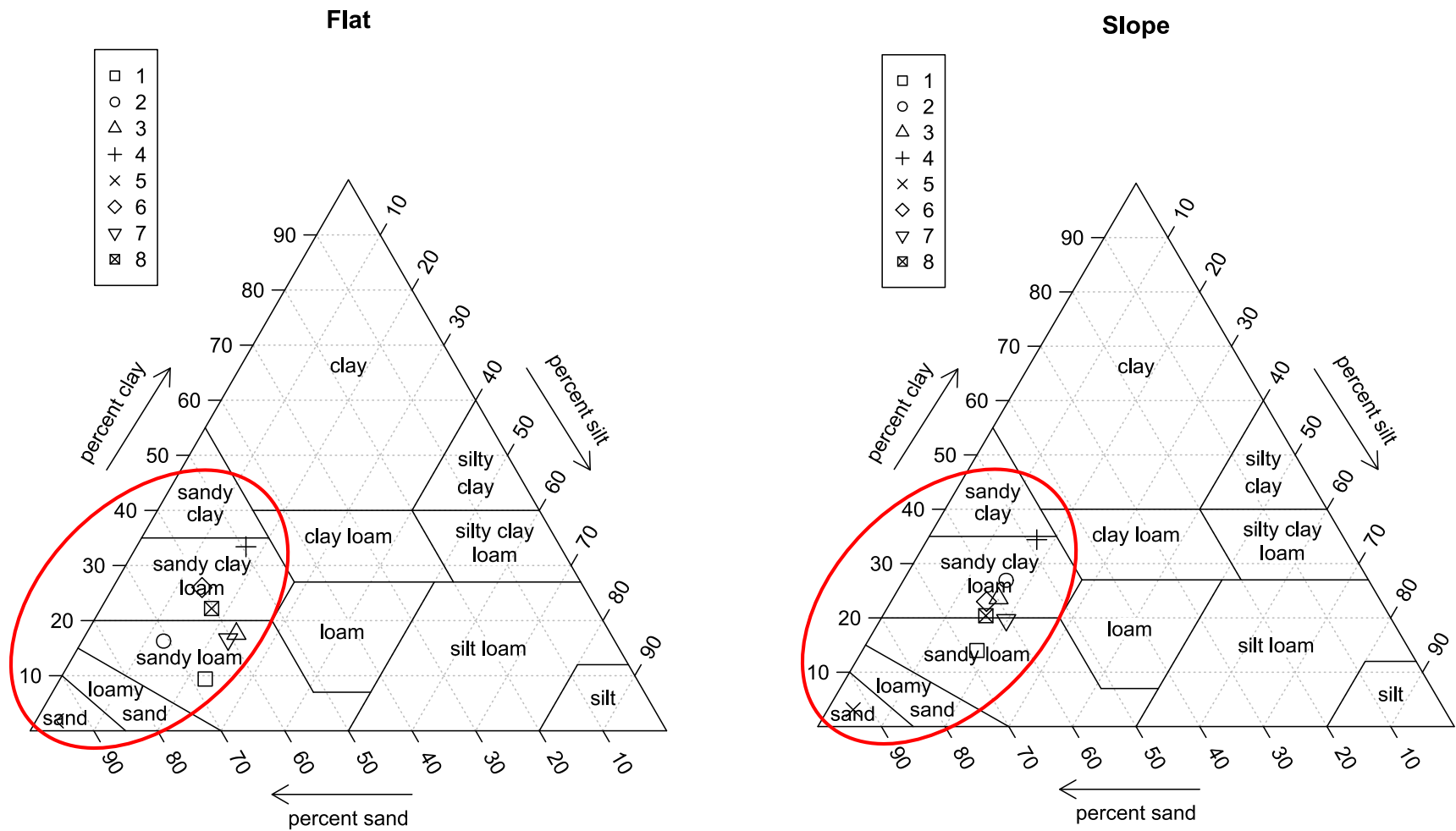
Small = 3-5 mm

Medium = 5-7 mm

Large = 7+ mm

Appendix 5: Mean diameter of nests' entrance of each plots' gradient (\pm SE, $N = 1,295$) measured in 2019 and 2020 surveys.

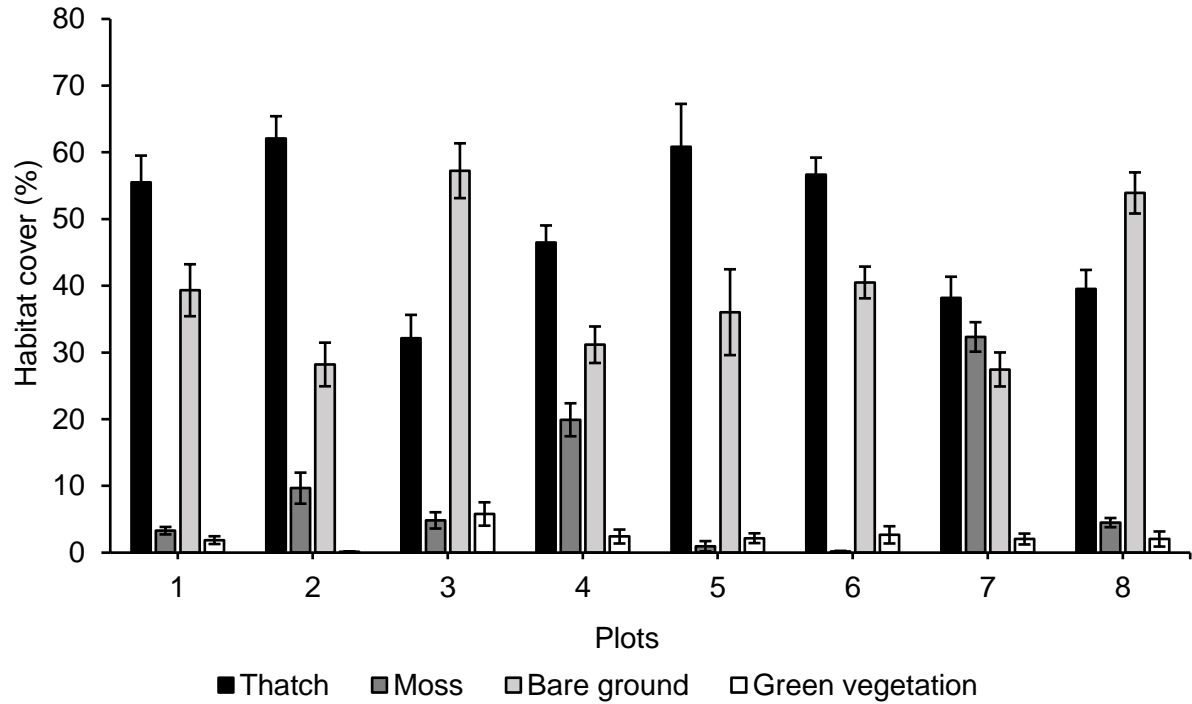
Plot	Mean \pm SE (n)	
	Flat (mm)	Slope (mm)
1	2.731 \pm 0.220 (21)	2.771 \pm 0.212 (19)
2	3.398 \pm 0.122 (103)	3.335 \pm 0.139 (64)
3	3.073 \pm 0.082 (138)	2.726 \pm 0.231 (14)
4	3.312 \pm 0.185 (59)	3.682 \pm 0.149 (105)
6	2.598 \pm 0.122 (84)	2.955 \pm 0.139 (103)
7	2.861 \pm 0.062 (171)	2.910 \pm 0.066 (152)
8	3.078 \pm 0.069 (138)	3.201 \pm 0.074 (124)



Appendix 6: Soil texture of plot's gradients. Each symbol in legends indicates the soil texture of the numbered plots determined from % of sand, silt, and clay.

Appendix 7: Mean soil temperature (°C) for the flat and sloping areas of each plot (\pm SE, $N = 405$) for early morning (01:00 – 05:00), late morning (07:00 – 11:00), afternoon (13:00 – 17:00), and night (19:00 – 23:00) from 30/03/2020 to 11/08/2020.

Plot	Gradient	Early morning	Late morning	Afternoon	Night
		Mean \pm SE (n)	Mean \pm SE (n)	Mean \pm SE (n)	Mean \pm SE (n)
1	Flat	17.58 \pm 0.22 (405)	17.06 \pm 0.22 (405)	21.30 \pm 0.24 (405)	20.60 \pm 0.25 (405)
1	Slope	16.61 \pm 0.21 (405)	15.88 \pm 0.20 (405)	21.83 \pm 0.26 (405)	20.73 \pm 0.26 (405)
2	Flat	16.73 \pm 0.24 (405)	16.69 \pm 0.24 (405)	20.59 \pm 0.26 (405)	19.67 \pm 0.26 (405)
2	Slope	16.87 \pm 0.25 (405)	16.93 \pm 0.24 (405)	20.73 \pm 0.27 (405)	19.83 \pm 0.27 (405)
3	Flat	16.91 \pm 0.25 (405)	17.31 \pm 0.25 (405)	22.35 \pm 0.27 (405)	20.60 \pm 0.27 (405)
3	Slope	16.02 \pm 0.25 (405)	16.44 \pm 0.25 (405)	20.77 \pm 0.27 (405)	19.32 \pm 0.27 (405)
4	Flat	17.31 \pm 0.27 (405)	17.24 \pm 0.22 (405)	22.82 \pm 0.27 (405)	20.77 \pm 0.24 (405)
4	Slope	16.52 \pm 0.21 (405)	17.47 \pm 0.23 (405)	23.64 \pm 0.26 (405)	20.03 \pm 0.23 (405)
5	Flat	15.07 \pm 0.21 (405)	16.01 \pm 0.22 (405)	19.21 \pm 0.21 (405)	17.31 \pm 0.21 (405)
5	Slope	15.12 \pm 0.22 (405)	16.25 \pm 0.23 (405)	19.63 \pm 0.27 (405)	17.25 \pm 0.20 (405)
6	Flat	17.11 \pm 0.25 (405)	17.33 \pm 0.25 (405)	21.68 \pm 0.27 (405)	20.42 \pm 0.27 (405)
6	Slope	16.86 \pm 0.24 (405)	17.99 \pm 0.26 (405)	23.84 \pm 0.29 (405)	20.87 \pm 0.27 (405)
7	Flat	17.23 \pm 0.23 (405)	17.46 \pm 0.23 (405)	22.80 \pm 0.27 (405)	20.74 \pm 0.26 (405)
7	Slope	17.56 \pm 0.24 (405)	17.31 \pm 0.23 (405)	23.07 \pm 0.27 (405)	21.38 \pm 0.27 (405)
8	Flat	17.24 \pm 0.24 (405)	17.96 \pm 0.25 (405)	23.44 \pm 0.28 (405)	21.12 \pm 0.27 (405)
8	Slope	17.01 \pm 0.24 (405)	17.04 \pm 0.24 (405)	22.03 \pm 0.27 (405)	20.54 \pm 0.27 (405)



Appendix 8: Mean (\pm SE, $N = 24$) percentage of vegetation cover on plots in spring and summer of 2020.

Appendix 9: Summary of GLMM analyses of soil variables for both 2018 and 2020. No variables predict peak nest density.

Predictor variables	Estimate	Std. Error	z value	P value	VIF
Year	-0.270	0.805	-0.336	0.737	2.989
Slope	-0.315	0.387	-0.815	0.415	1.463
Hydraulic conductivity	-1.078	0.697	-1.546	0.122	1.422
Soil compaction	0.184	0.169	1.087	0.277	1.300
Soil organic matter	0.096	0.170	0.567	0.571	1.108
Soil root biomass	-0.620	0.883	-0.702	0.482	1.737
Soil water content	0.299	0.292	1.026	0.305	1.343
Soil stoniness	0.325	0.323	1.007	0.314	2.253
Soil texture (Sand)	0.008	0.557	0.014	0.989	1.400



Appendix 10: Nests of solitary ground-nesting bees with “chimneys” extending from nest entrance.