BEESPOKE Frisian Clay area: grasslands, herb-richness and insect biodiversity.

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Problem: The Frisian clay area has a large amount of grasslands. Intensive production in grasslands reduces variation of plants, both grasses and herbs. This reduces the variation in possibilities for other members of the grassland ecosystem, e.g. insects and meadow birds. Can we find reflections of the effects of intensive use and differences in herb-richness on insect diversity with easy to perform insect biodiversity assessment techniques? To investigate that, we used the BEESPOKE insect measurements using pitfalls for soil roaming insects, pan traps for flower seeking insects and sticky traps for flying insects.

Methods: In 2022, we measured herb-richness and insect diversity in established fields within the BEESPOKE Frisian clay landscape: 4 intensively used fields and 13 herb-rich fields (10 developed herb-richness under less intensive management, 3 by sowing a herb-rich mixture; see figure 1 for examples). Herb-richness of grassland fields was measured in May 2022 before the first mowing, by averaging 3 Braun-Blanquet coverage assessments of 2*2m plots at >15m distance from the nearest ditch and >20m distance from each other. Herb-richness was measured as 1) number of herb species (>20 used as lower boundary value), 2) coverage % of herbs (>20% coverage used as boundary value; Nature type N12.02 Herb- and fauna rich grassland; www.bij12.nl), and 3) with a quality assessment combining the indicative value of observed species and their coverage (Q-value: summation of all the species Q-values, calculated as the quality category of the species multiplied by their fractional coverage at 100m^2; >2.5 indicates an acceptable boundary, >3.5 a good boundary; van 't Veer, 2022).

Figure 1. *Example of intensive (other side of the ditch) and herb-rich grassland fields in May 2022.*

Insects were caught at the same 3 locations per field with different techniques. Pitfall traps were used at all 3 locations for analyses of ground dwelling Arthropods, and specifically for Carabid beetles. Pan traps (blue, yellow, white) were used at the middle location to catch flower attracted species at the height of the flowering vegetation. Yellow sticky traps were used at all 3 locations to

catch yellow attracted flying insects at a height of 20-45cm above the soil. These measurements were done in early May before mowing of intensive fields, in early June before mowing of the herb-rich fields, and in August (1 intensive and 2 herb-rich fields were not available because of mowing and grazing activities). For detailed descriptions of measurements and analyses, see Strijkstra et al. (2023a,b,c).

Insects were determined to easily achievable taxonomic levels. For pitfall traps this was always achieved to the level of class, most always to the level of order, for a smaller fraction to the level of family, and to species level for Carabid beetles, as well as occasional bees, butterflies, and hoverflies. For pan traps, this was always achieved to the level of class, most always to the level of order, for a smaller fraction to the level of family, and to species level for bees, hoverflies, and occasional for butterflies and dragonflies. For sticky traps, this was always achieved to the level of class, most always to the level of order, for a smaller percentage to the level of family, and to species level for Bees and Hoverflies, and occasional for butterflies and dragonflies.

Analyses were done to indicate differences in insect numbers, numbers of individuals in different taxonomic groups, estimated numbers of richness of families and species (species richness index Chao-1), estimated diversity of families and species (species diversity index Shannon entropy), and for sticky traps also numbers and estimated biomass per 1mm length category between 0-15mm, and >15mm.

Herb-richness: A total of 42 plant species were observed by the Braun-Blanquet coverage inventories: 14 grass species and 28 herb species. 22 Species were only seen in the herb-rich fields. Number of observed species (grasses and herbs) was 7.0 (range 5-10) for intensive fields, and 12.9 (range 6-20) for herb-rich fields. 1 Field had 20 species. Herb coverage was 4.3% (range 0.0-8.5%) for intensive fields, and 21.18% (range 1.1-41.2%) for herb-rich fields. 7 Fields had >20% herb coverage. Q-values were 1.2 (range 1.1-1.3) for intensive fields, and 2.2 (range 1.5-3.5) for herb-rich fields. 4 Fields had Q-values >2.5, 1 field >3.5. These differences between the groups were significant.

The fields were ranked for their Q-value from high to low, separately for the intensive reference group and the herb-rich group. *Lolium perenne* (Q-value=1) had the largest coverage estimates, ranging between 63.0% and 71.33% at intensive fields, and between 9,67% and 63.00% in herb-rich fields. This coverage was significantly higher in the intensive reference group, as for *Poa annua* (Q-value=2). Other grasses had significantly higher coverage in the herb-rich group (*Bromus hordeaceus* (Q-value =3), *Alopecurus geniculatus* (Q-value =3)). Specifically in the 4 highest Q-value ranking herb-rich fields, low coverage of *Lolium perenne* (9,67-31,33%) co-occurred with higher coverage of grass species with higher Q-values (e.g. *Alopecurus pratensis* (Q-value =3), *Holcus lanatus* (Q-value =3), *Anthoxanthum odoratum* (Q-value =5)), and also with significant increased coverage of several herb species with higher Q-values (e.q. *Cerastium fontanum* (Q-value =2), *Trifolium repens* (Q-value =3), *Rumex crispus* (Q-value =3), *Ranunculus acris* (Q-value =4), *Rumex acetosa* (Q-value =4), *Cardamine pratensis* (Q-value =4), *Ranunculus repens* (Q-value=6)). Many other herb and grass species were only observed in the herb-rich group, but not consistently enough to cause a significant difference on single species level. Relatively high herb coverage was found for the 3 fields with sown herb-richness (34.2%, 13.4%, 33.9%), however with sub-average Q-values (2.0, 1.8, 1.6). (Data in Appendix 1).

Pitfall traps: In total, 3358 *Arthropoda* were caught in the pitfalls. High numbers of *Insecta* were found for the orders *Diptera*, *Coleoptera*, and *Hymenoptera*. 23 Insect families were observed within the Insect orders. *Coleoptera* were found in slightly higher numbers in intensive fields compared to herb-rich fields, mainly attributable to *Carabidae*. Out of the 11 *Coleoptera* families, 8 were found in

higher numbers in intensive fields. *Diptera* were found in slightly higher numbers in intensive fields compared to herb-rich fields. Of the 7 *Diptera* families, 5 were found in higher numbers in intensive fields, mainly attributable to *Scatophagidae* and *Empididae*. *Hymenoptera* were found in slightly higher numbers in intensive fields compared to herb-rich fields. Out of the 5 *Hymenoptera* families, 3 were found in higher numbers in intensive fields, mainly attributable to *Chalcididae* and *Ichneumonidae*. No significant differences were found between intensive and herb-rich fields in number of individuals per family, except for *Auchenorrhyncha* (n=12) and the *Nematocera* subgroup (n=37) of *Diptera*, both with higher numbers in herb-rich fields.

Average number of individuals in families per field, as well as number of families per field, estimated family richness (CHAO-1), and estimated family diversity (Shannon entropy) was on average slightly higher in intensive fields. However, no significant differences were found between intensive and herb-rich fields. (Data in Appendix 2).

Carabid beetles: The 360 *Carabidae* (Loopkevers) were determined to species level. In total 21 species were observed. 12 Species were observed in intensive fields, of which 3 (6 individuals) were not observed in herb-rich fields. 18 Species were observed in herb-rich fields of which 3 were Reed vegetation specialists, and of which 9 (30 individuals) were not observed in intensive fields. Number of observed individuals was slightly higher in intensive fields. Number of observed species, estimated number of species (Chao-1) and estimated diversity (Shannon entropy) were slightly lower in intensive fields. However, no significant differences in abundance of any of the species were found between intensive and herb-rich fields, except for a higher average number of *Bembidion guttula* (Weidepriemkever, a grassland specialist species) in herb-rich fields.

Pan traps: In total, 8717 *Arthropoda* were caught in the pan traps, of which 8702 *Insecta* (Insecten). High numbers of *Insecta* were found for the orders *Diptera, Hymenoptera* and in lower numbers also *Coleoptera*. In total 4532 individuals of 29 Insect families were observed within the Insect orders. Out of the 14 *Diptera families*, 7 were found in higher numbers in intensive fields, mainly attributable to *Scatophaidae*, *Empididae*, *Dolichopodidae*, and *Syrphidae*. *Diptera* were found in slightly higher numbers in intensive fields (247,0 per field) compared to herb-rich fields (226,6). Of the 5 *Hymenoptera* families, 2 were found in higher numbers in intensive fields, mainly attributable to *Ichneumonidae*. *Hymenoptera* were found in slightly higher numbers in intensive fields (19,8) compared to herb-rich fields (12,2). Out of the 7 *Coleoptera* families, only 2 were found in higher numbers in intensive fields. *Coleoptera* were found in slightly higher numbers in intensive fields (5,3) compared to herb-rich fields (3,8). No significant differences were found between intensive and herb-rich fields in number of individuals per family.

Average number of individuals in Families per field, as well as number of Families per field, estimated family richness (CHAO-1), was on average slightly higher in intensive fields. This was significantly so for number of Families. Estimated Family diversity (Shannon entropy) was slightly but not significantly lower in intensive fields. (Data in Appendix 2).

Hoverflies: The 739 Syrphidae (Hoverflies) were determined to species level. In total 20 species were observed. 17 Species were observed in intensive fields, of which 2 (n=2) were not observed in herb-rich fields. 18 Species were observed in herb-rich fields of which 3 (n=12) were not observed in intensive fields. For all the different fields, number of observed individuals and number of observed species were slightly higher in intensive fields. Estimated number of species (Chao-1) and estimated diversity (Shannon entropy) was slightly lower in intensive fields. However, no significant differences between intensive and herb-rich fields were found. (Data in Appendix 2)

Some bees were alto caught in low numbers, on average 1,75 in intensive fields and 1,85 in herb-rich fields. *Bombus pascuorum* and *Bombus terrestris* were caught in similar numbers in intensive (1,25) and herb-rich fields (1,08). *Andrena tibialis, Apis mellifera* and *Lasioglossum leucopus* were each caught once in a herb-rich field.

Sticky traps: In total, 21781 *Arthropoda* were caught and recognized on the sticky traps, of which 13661 were recognized as member of 7 Orders. High numbers of *Insecta* were found for the Orders *Diptera, Hymenoptera, Thysanoptera,* and in lower numbers also *Hemiptera* and *Coleoptera* and a few *Neuroptera* and *Ephemeroptera.* 2088 Individuals of 20 families were observed within the Insect orders. Out of the 14 *Diptera families*, 12 were found in higher numbers in herb-rich fields, mainly attributable to *Dolichopodidae*, *Sepsidae*, *Scatophaidae*, and *Calliphoridae*. *Diptera* were found in slightly lower numbers in intensive fields (64,3) compared to herb-rich fields (116,9). *Hymenoptera* were mostly determined to super-families, but *Tenthredinidae* were slightly higher in intensive fields. Out of the 4 *Coleoptera* families, 2 were found in higher numbers in intensive fields. *Coleoptera* were found in slightly higher numbers in intensive fields (18,5) compared to herb-rich fields (9,9), mainly caused by *Staphylinidae*. Significant differences were found between intensive and herb-rich fields in number of individuals per family for *Dolichopodidae* ($p<0.05$) and marginally for *Rhagionidae* ($p<0.10$).

Averages per field for individuals in Orders, number of Orders, individuals in Families, number of Families, estimated number of Families (Chao-1) and diversity of Families (Shannon entropy) was on average slightly higher in herb-rich fields. This was bordering significance for number of Families ($p<0.10$). Estimated Family diversity (Shannon entropy) was slightly but not significantly lower in intensive fields. (Data in Appendix 2).

Hoverflies: The 317 Syrphidae (Hoverflies) were determined to species level. In total 10 species were observed. 8 Species were observed in intensive fields. All 10 species were observed in herb-rich fields of which 2 (n=3) were not observed in intensive fields. For all the different fields, number of observed individuals and number of observed species were slightly higher in intensive fields, as in the Pan trap data. However, no significant differences between intensive and herb-rich fields were found. (Data in Appendix 2)

Insect length and biomass: The automatic Insect detection and length and biomass calculation resulted in 21858 detected object length. These were corrected for the number of repeated measurements taken in the season. This resulted in average numbers of objects detected in a measurement round per field yielding 420,5 objects (per 3 sticky traps on a location) for intensive fields, and slightly higher at 508.2 (per 3 sticky traps) objects for herb-rich fields. The higher numbers occurred at all length categories, except for the 14-15mm and >15mm length categories. And reached significance for the 6-7mm category ($p<0.05$), and marginally also for the 5-6mm and 1-2mm categories ($p<0.10$).

Similar to the length data, biomass calculated from length was also slightly higher in herb-rich fields (494.3mg, per 3 sticky traps), and higher biomass occurred at all length categories except the >14mm length categories. The length categories between 5-7mm were both significantly different ($p<0.05$); differences in the 1-2mm ($p=0.110$) and 7-8mm categories ($p=.105$) were marginal. (Data in Appendix 2)

Conclusion: Intensive use on grasslands indeed had low values for plant- and herb-richness and diversity: number of plant species, herb cover and Q-values differed between the 4 intensive and 13 herb-rich fields. In view of the low number of fields sampled, compared to the high variability of

plant species presence and coverage, a lack of detected differences for single species may be expected. Lack of differences may also have occurred because of the relatively low values in herb-richness between the fields: there was a remarkable overlap between intensive and herb-rich fields in herb-richness measures, and many of the herb-rich fields did not reach 20 species, or 20% herb cover, or a Q-value of >2.5. This may be partly related to a difference in surface area observed: we observed 3x4m^2, where usually 25m^2 (for species and herb cover estimates) or 100m^2 (for Q-value estimates) are used. Introduced herb-richness (herb-rich cases Kroodsma, Kroodsma1, Kroodsma2) did result in relatively high herb cover, but did not rank high in overall Q-value.

The pitfall trap data and the pan trap data did not indicate much difference between intensive and herb-rich fields in an large set of variables. The sticky traps were more successful in detecting differences between intensive and herb-rich fields. This indicates that under these conditions the flying insects targeted by sticky traps appear more sensitive to the effects of intensive use, rather than soil roaming insects or flower seeking insects. The detected sticky trap differences indicated generally more insects per insect group in the herb-rich fields.

Specifically, the insects of the important mid-size categories (4-12mm) were caught in higher numbers, also leading to increased estimated biomass in that size category. The mid-size categories entail several insect groups that are of importance for meadow birds. Attracting more flower seeking insects (pollinators) may require more herb-richness and more stable flowering.

Since the sticky trap analysis method has been used also in other BEESPOKE research, data could directly be compared to that of flower strips, ditch sides and several other crops. The grassland data ranks relatively low in several measures of biodiversity, ranking above potato but below other crops (cereals, rape seed, broad beans, flax) and far below flower-rich flower strips and ditch sides next to the observed crops. For detailed information on this comparison, see Boerema et al. (2023).

References.

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Appendix 1. *Observed grasses and herbs species and their Q-values for the 17 BEESPOKE grassland fields. Observed coverage data (as %, derived from Braun-Blanquet data) and the average values for intensive reference plots and herb-rich plots (mean %, SEM %) are given, and the significance of differences per species (tested with a t-test for assumed heteroscedastic data; p-values: *<0.05, **<0,01, ***<0,001). Green colour shading indicate relative coverage values. For coverage data per field, colour intensity is expressed per species, or # of species, relative cover, or Q-index data, to highlight the differences between fields. For average coverage data per group of fields (intensive reference, herb-rich), colour intensity is expressed over all species to highlight the species occurrence patterns between the groups.*

species name	Dutch species name		Intensive reference				Herb-rich																	
		Q-value	Kroodsma	Dijkstra	Bakker	Vellinga	Idzardl2	SBB	Idzardl1	Westra	Dijkstra	Marinus	Kroodsma	Kroodsma2	Vellinga2	Sibma	Kroodsma1	Nobel	Vellinga1	intensive	SEM	herb-rich	SEM	t-test
			%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	sign
Grasses																								
Lolium perenne	Engels raaigras	1	63,00	63,00	71,33	71,33	9,67	18,00	18,00	31,33	38,00	48,00	46,33	63,00	54,67	63,00	38,00	54,67	63,00	67,17	2,41	41,97	5,09	***
Lolium multiflorum	Italiaans raaigras	1	12,00	4,67	0,00	13,00	0,00	0,00	0,00	0,00	0,00	0,00	4,67	0,00	0,00	2,00	0,67	6,33	0,67	7,42	3,09	1,10	0,57	
Poa pratensis	Veldbeemdgras	1	0,00	0,00	0,00	0,00	2,67	0,00	0,00	0,00	0,00	0,67	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,26	0,21	
Poa annua	Straatgras	2	4,67	11,33	5,00	4,67	0,00	0,00	0,00	0,00	0,00	1,00	3,00	2,33	0,00	0,00	2,67	3,00	0,00	6,42	1,64	0,92	0,36	*
Poa trivialis	Ruw beemdgras	2	0,00	0,00	3,33	0,00	0,00	0,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,67	0,00	0,83	0,83	0,13	0,09	
Festuca arundinacea	Rietzwenkgras	2	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,33	0,00	0,00	0,25	0,25	0,10	0,10	
Alopecurus pratensis	Grote vossenstaart	3	0,00	0,00	0,00	1,00	2,67	38,00	24,67	0,00	0,00	0,67	0,00	0,00	0,00	0,00	0,00	0,00	4,33	0,25	0,25	5,41	3,30	
Bromus hordeaceus	Zachte dravik s.l.	3	0,00	0,00	0,00	0,00	5,00	6,33	2,00	4,67	11,33	3,67	0,00	8,00	3,00	21,33	0,00	2,67	3,00	0,00	0,00	5,46	1,58	**
Alopecurus geniculatus	Geknikte vossenstaart	3	1,00	0,00	0,33	0,00	1,00	0,00	0,00	1,33	0,00	6,00	2,67	9,67	4,67	7,00	0,67	16,33	4,00	0,33	0,24	4,10	1,33	*
Holcus lanatus	Gestreepte witbol	3	0,00	0,00	0,67	0,00	14,67	0,00	5,33	0,67	4,33	9,67	0,00	0,00	0,00	0,00	0,00	0,67	0,00	0,17	0,17	2,72	1,29	
Dactylis glomerata	Kropaar	3	0,00	0,00	0,00	0,00	0,00	3,67	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,28	0,28	
Agrostis stolonifera	Fioringras	4	1,00	0,00	0,00	0,00	0,67	0,00	0,00	0,00	0,00	0,00	0,00	0,00	12,67	2,67	0,00	0,00	0,67	0,25	0,25	1,28	0,97	
Agrostis capillaris	Gewoon struisgras	4	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,67	0,67	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,10	0,07	
Anthoxanthum odoratum	Gewoon reukgras	5	0,00	0,00	0,00	0,00	21,33	4,67	3,33	2,33	0,00	2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,59	1,62	
Herbs																								
Taraxacum species	Paardenbloem (G)	2	1,67	2,33	0,00	0,00	0,00	0,00	0,00	2,67	2,67	2,33	0,67	2,00	2,33	1,00	2,00	2,00	2,33	1,00	0,59	1,54	0,29	
Cerastium fontanum	Gewone / Glanzende hoornbloem	2	0,00	0,00	0,00	0,00	2,00	0,00	0,67	2,00	1,00	0,67	0,00	0,67	2,00	0,00	0,00	0,00	2,33	0,00	0,00	0,87	0,25	*
Plantago major s. major	Grote weegbree s.s.	2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	8,00	0,00	0,00	0,00	0,00	0,62	0,62	
Rumex obtusifolius	Ridderzuring	2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,67	0,00	0,00	0,00	0,00	0,00	4,00	0,00	0,00	0,00	0,00	0,51	0,36	
Stellaria media	Vogelmuur	2	0,67	2,33	0,00	0,33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,83	0,52	0,00	0,00	
Cerastium glomeratum	Kluwenhoornbloem	2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,33	0,00	0,00	0,10	0,10	
Rorippa sylvestris	Akkerkers	2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,03	0,03	
Cirsium vulgare	Speerdistel	2	0,00	0,00	0,00	0,00	0,00	0,33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,03	0,03	
Trifolium repens	Witte klaver	3	3,67	1,00	0,00	0,00	1,67	0,00	0,00	3,33	0,67	6,33	18,00	1,33	0,67	0,00	4,67	0,00	0,00	1,17	0,87	2,82	1,38	
Rumex crispus	Krulzuring	3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,33	1,00	0,00	0,00	0,67	0,00	1,00	0,00	0,00	0,31	0,14	*
Cardamine hirsuta	Kleine veldkers	3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,67	0,00	0,00	0,00	0,00	0,00	0,00	0,05	0,05	
Polygonum aviculare	Gewoon varkensgras	3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,33	0,00	0,00	0,00	0,00	0,03	0,03	
Ranunculus acris	Scherpe boterbloem	4	0,00	0,00	0,00	0,00	11,33	2,67	7,67	2,00	4,67	4,33	0,00	1,33	0,67	0,00	0,00	0,67	0,67	0,00	0,00	2,77	0,96	*
Rumex acetosa	Veldzuring	4	0,00	0,00	0,00	0,67	4,67	0,00	1,67	1,33	4,33	2,67	0,00	0,00	0,00	0,00	0,00	0,00	0,67	0,17	0,17	1,18	0,47	
Cardamine pratensis	Pinksterbloem	4	0,00	0,00	0,00	0,00	1,33	1,33	2,33	2,00	1,33	3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,87	0,30	*
Ficaria verna	Speenkruid	4	0,00	0,67	0,00	0,00	1,00	6,67	0,67	2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,17	0,17	0,79	0,52	
Trifolium pratense	Rode klaver	4	0,00	0,00	0,00	0,00	0,67	2,67	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,67	0,00	0,00	0,00	0,31	0,21	
Anthriscus sylvestris	Fluitenkruid	4	0,00	0,00	0,00	0,00	0,33	1,00	0,00	0,67	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,15	0,09	
Bellis perennis	Madeliefje	4	0,00	0,00	0,00	0,00	1,67	0,00	0,00	0,33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,15	0,13	
Trifolium dubium	Kleine klaver	5	0,00	0,00	0,00	0,00	1,67	0,00	0,00	1,67	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,26	0,17	
Cichorium intybus	Wilde cichorei	5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,00	0,00	0,00	0,00	1,33	0,00	0,00	0,00	0,00	0,26	0,18	
Plantago lanceolata	Smalle weegbree	5	0,00	0,00	0,00	0,00	0,00	0,00	0,33	0,00	0,00	0,00	2,00	0,00	0,00	0,00	0,67	0,00	0,00	0,00	0,00	0,23	0,16	
Geranium molle	Zachte ooievaarsbek	5	0,00	0,00	0,00	0,00	0,00	1,00	0,00	2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,23	0,17	
Vicia sativa	Smalle en Voederwikke	5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,15	0,15	
Achillea millefolium	Gewoon duizendblad	5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,10	0,10	
Ranunculus repens	Kruipende boterbloem	6	1,67	0,00	0,00	0,00	2,00	1,67	2,33	4,33	5,33	4,67	1,67	6,33	1,33	0,00	0,67	0,00	1,33	0,42	0,42	2,44	0,57	*
Ranunculus sardous	Behaarde boterbloem	6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,15	0,15	
Carum carvi	Echte karwij	7	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,10	0,10	
# species	grasses	#	6,00	3,00	5,00	4,00	8,00	5,00	6,00	6,00	4,00	8,00	4,00	4,00	4,00	5,00	5,00	7,00	6,00	4,50	0,65	5,54	0,40	
# species	herbs	#	4,00	4,00	0,00	2,00	11,00	8,00	7,00	14,00	8,00	7,00	9,00	6,00	6,00	1,00	9,00	3,00	7,00	2,50	0,96	7,38	0,90	**
# species	total	#	10,00	7,00	5,00	6,00	19,00	13,00	13,00	20,00	12,00	15,00	13,00	10,00	10,00	6,00	14,00	10,00	13,00	7,00	1,08	12,92	1,03	**
relative cover	% herbs	%	8,54	7,48	0,00	1,15	32,19	18,92	22,10	41,23	29,50	24,81	34,18	13,14	9,30	1,07	33,92	3,83	11,13	4,29	2,17	21,18	3,54	**
Q-index	at 100% coverage		1,32	1,23	1,13	1,10	3,55	2,94	2,84	2,66	2,28	2,23	2,00	1,84	1,83	1,68	1,64	1,56	1,51	1,19	0,05	2,20	0,17	***

Appendix 2. *Summary of biodiversity data obtained with pitfall traps, pan traps, and sticky traps for the comparison with plant diversity and the differences between intensive and herb-rich grasslands. 17 Fields were investigated for differences between intensively used fields (intensive) and herb-rich denoted fields (herb-rich). Plant species and coverage was investigated with the Braun-Blanquet method, insects were investigated for family richness and diversity of soil insects, flower seeking insects, and flying insects, for species richness of a focus family (Carabidae for pitfall traps, Syrphidae for pan traps and sticky traps), and for the length and biomass distribution of flying insects. T-tests were used as indication for differences (+p<0.10, *p<0.05, **p<0.01, ***p<0.001). Green colour indicates relatively high numbers comparing intensive and herb-rich situations.*

Method	Test	index	indicator	Kroodsma	Dijkstra	Bakker	Vellinga	Idzardi2	SBB	Idzardi1	Westra	Dijkstra	Marinus	Kroodsma	Kroodsma2	Vellinga2	Sibma	Kroodsma1	Nobel	Vellinga1	All	Intensive	SEM	Herb-rich	SEM	t-test
				Intensive				Herb-rich																		
Braun-Blanquet	Plants	# species	# grasses	6	3	5	4	8	5	6	6	4	8	4	4	4	5	5	7	6	14	4,5	0,6	5,5	0,4	
Braun-Blanquet	Plants	# species	# herbs	4	4	0	2	11	8	7	14	8	7	9	6	6	1	9	3	7	28	2,5	1,0	7,4	0,9	**
Braun-Blanquet	Plants	# species	# plants	10	7	5	6	19	13	13	20	12	15	13	10	10	6	14	10	13	42	7,0	1,1	12,9	1,0	**
Braun-Blanquet	Plants	relative cover	% herb cover	8,54	7,48	0,00	1,15	32,19	18,92	22,10	41,23	29,50	24,81	34,18	13,14	9,30	1,07	33,92	3,83	11,13		4,3	2,2	21,2	3,5	**
Braun-Blanquet	Plants	Q-index	Q-index	1,32	1,23	1,13	1,10	3,55	2,94	2,84	2,66	2,28	2,23	2,00	1,84	1,83	1,68	1,64	1,56	1,51		1,2	0,1	2,2	0,2	***
Pitfall traps	Soil insects	Family	# individuals	59	78	141	30	68	10	40	27	35	65	45	22	55	14	116	50	36	891,0	77,0	23,5	44,8	7,7	
Pitfall traps	Soil insects	Family	# families	7	12	12	8	13	3	13	8	8	8	10	5	10	6	10	7	9	23,0	9,8	1,3	8,5	0,8	
Pitfall traps	Soil insects	Family richness	CHAO-1	14,9	12,7	19,9	9	19,2	3		9,2	9	8	15,9	6,9	13,9	7,9	10,7	9	26,5	25,2	14,1	2,3	11,6	1,8	
Pitfall traps	Soil insects	Family diversity	Shannon entropy	1,182	2,006	2,02	1,943	1,917	1,137	2,004	1,63	1,611	1,764	2,091	1,363	1,798	1,953	1,566	1,48	1,674	2,099	1,788	0,203	1,691	0,075	
Pitfall traps	Soil insects	Carabidae	# individuals	35	31	29	10	35	5	24	13	20	15	15	11	24	4	41	26	22	360,0	26,3	5,6	19,6	3,0	
Pitfall traps	Soil insects	Carabidae	# species	5	8	8	4	8	4	11	6	8	5	4	3	7	3	11	9	6	21,0	6,3	1,0	6,5	0,8	
Pitfall traps	Soil insects	Carabidae richness	CHAO1	9,4	9,9	9	4,4	8,5		14	10,2	10,8	5,9	4,9	3	7,2		20,8	10,4	8,9	29,0	8,2	1,3	9,5	1,5	
Pitfall traps	Soil insects	Carabidae diversity	Shannon entropy	0,731	2,034	1,939	1,479	2,032		2,483	1,975	2,253	1,626	1,272	0,961	1,868		2,23	2,145	1,71	2,383	1,546	0,297	1,869	0,136	
Pantraps	Flower insects	Family	# families	14	13	14	13	9	14	13	11	12	10	11	13	13	11	14	12	15	29,0	13,5	0,3	12,2	0,5	
Pantraps	Flower insects	Family richness	CHAO1	17,2	20,2	33	18	10,5	21,2	16,7	12	13,2	14	13	16,2	18	12,2	19	17,5	40,5	35,1	22,1	3,7	17,2	2,1	
Pantraps	Flower insects	Family diversity	Shannon entropy	1,367	1,046	1,642	1,646	1,401	1,734	1,829	1,599	1,421	1,575	1,051	1,524	1,462	1,703	1,331	1,531	1,6	1,878	1,425	0,142	1,520	0,055	
Pantraps	Flower insects	Syrphidae	# individuals	55	37	83	13	9	96	49	21	42	28	42	40	25	72	45	54	28	739,0	47,0	14,8	42,4	6,3	
Pantraps	Flower insects	Syrphidae	# species	13	9	13	5	4	15	11	7	10	6	9	12	9	9	9	11	12	20,0	10,0	1,9	9,5	0,8	
Pantraps	Flower insects	Syrphidae richness	CHAO-1	17,4	9,2		7,8	4,9	27,4	18,8	11,3	12,2	6,5	13,4	13,5	11,2	9	11,9	12		22,2	11,5	3,0	12,7	1,7	
Pantraps	Flower insects	Syrphidae diversity	Shannon entropy	2,494	2,178	1,906	1,611	1,528	2,262	2,002	1,835	2,085	1,597	2,064	2,384	2,217	1,793	2,051	2,217	2,685	2,270	2,047	0,189	2,055	0,088	
Sticky traps	Flying insects	Family	# families	11	9	8	10	9	13	11	14	11	8	9	10	12	11	12	13	12	20	9,5	0,6	11,2	0,5	+
Sticky traps	Flying insects	Family richness	CHAO1	15,5	11	10	13	13,4	13,7	15,5	17	14	8,5	9	11	16	15,5	13	14	14	22,2	12,4	1,2	13,4	0,7	
Sticky traps	Flying insects	Family diversity	Shannon entropy	1,995	1,66	1,896	1,998	1,945	2,05	1,85	2,283	1,84	1,678	2,069	2,032	1,693	1,774	1,898	1,907	2,091	2,201	1,9	0,1	1,9	0,0	
Sticky traps	Flying insects	Syrphidae	# individuals	22	51	8	3	5	18	15	3	34	14	18	10	15	9	15	53	24	317	21,0	10,8	17,9	3,7	
Sticky traps	Flying insects	Syrphidae	# species	7	8	6	2	3	5	5	3	7	6	6	6	3	4	5	6	3	10	5,8	1,3	4,8	0,4	
Sticky traps	Flying insects	Syrphidae richness	CHAO-1	8	8,2				5,5	6,9		8	10,2	6,2		3		5,5	6		10,5	8,1	0,1	6,4	0,7	
Sticky traps	Flying insects	Syrphidae diversity	Shannon entropy	1,909	1,799				1,601	1,563		1,757	1,93	1,712		2,403		1,658	1,431		1,812	1,9	0,1	1,8	0,1	
Sticky traps	Flying insects	0-1mm	# individuals	228,0	178,7	145,7	40,5	151,0	117,3	134,7	158,7	236,3	22,5	169,3	190,3	140,3	97,0	215,3	216,0	109,3	2551,0	148,2	39,7	150,6	16,1	
Sticky traps	Flying insects	1-2mm	# individuals	166,7	170,0	138,7	169,5	148,0	133,7	164,3	221,0	402,7	158,5	183,0	249,0	166,3	467,5	182,3	215,7	172,0	3508,8	161,2	7,5	220,3	28,1	+
Sticky traps	Flying insects	2-3mm	# individuals	31,7	59,3	34,0	69,0	27,0	31,7	22,3	95,3	69,7	55,5	42,7	61,0	54,7	78,0	67,0	49,7	50,7	899,2	48,5	9,3	54,2	5,7	
Sticky traps	Flying insects	3-4mm	# individuals	18,0	11,0	13,3	21,0	8,0	19,0	12,0	24,0	18,7	18,0	21,7	19,3	23,3	15,5	47,7	14,7	14,3	319,5	15,8	2,3	19,7	2,6	
Sticky traps	Flying insects	4-5mm	# individuals	11,3	16,7	11,3	9,0	8,7	11,3	7,0	11,7	14,7	11,5	14,3	11,7	11,0	22,0	13,0	11,0	9,0	205,2	12,1	1,6	12,1	1,0	
Sticky traps	Flying insects	5-6mm	# individuals	4,7	9,0	4,0	4,0	4,3	11,0	10,3	7,3	8,7	4,5	7,3	10,0	11,7	11,5	15,7	6,3	5,3	135,7	5,4	1,2	8,8	0,9	+
Sticky traps	Flying insects	6-7mm	# individuals	7,0	8,0	5,3	11,5	7,3	14,3	11,3	10,7	18,7	14,0	8,0	11,3	14,3	19,0	24,3	13,7	6,3	205,2	8,0	1,3	13,3	1,4	*
Sticky traps	Flying insects	7-8mm	# individuals	7,7	11,0	6,0	6,5	6,7	8,0	7,0	14,7	11,3	7,0	8,7	7,3	11,0	10,5	22,3	11,3	11,0	168,0	7,8	1,1	10,5	1,2	
Sticky traps	Flying insects	8-9mm	# individuals	3,3	9,3	2,3	2,0	4,3	5,7	6,3	8,0	7,0	6,5	3,7	5,0	9,7	12,5	10,7	7,3	5,3	109,0	4,3	1,7	7,1	0,7	
Sticky traps	Flying insects	9-10mm	# individuals	3,0	6,3	2,0	3,0	2,0	5,3	3,7	2,7	6,3	4,5	1,7	2,3	3,7	5,0	5,0	5,3	5,0	66,8	3,6	0,9	4,0	0,4	
Sticky traps	Flying insects	10-11mm	# individuals	1,0	2,7	0,7	1,5	0,7	3,3	2,0	3,0	2,7	1,0	1,3	1,7	2,0	5,5	2,3	1,3	3,3	36,0	1,5	0,4	2,3	0,4	
Sticky traps	Flying insects	11-12mm	# individuals	0,0	2,7	0,0	0,0	0,7	1,0	2,3	1,0	2,3	1,5	0,3	0,7	2,0	4,0	1,0	2,3	1,0	22,8	0,7	0,7	1,6	0,3	
Sticky traps	Flying insects	12-13mm	# individuals	1,3	1,0	0,0	0,0	0,3	1,0	0,0	0,3	1,0	1,0	1,0	0,3	0,0	3,5	0,0	2,3	1,0	14,2	0,6	0,3	0,9	0,3	
Sticky traps	Flying insects	13-14mm	# individuals	0,3	1,7	0,7	1,0	0,3	1,3	1,0	0,7	1,3	1,0	0,7	1,0	0,0	4,0	1,0	2,3	0,0	18,3	0,9	0,3	1,1	0,3	
Sticky traps	Flying insects	14-15mm	# individuals	1,0	2,7	0,0	0,0	0,0	0,7	1,3	0,3	0,3	0,0	1,3	0,0	0,3	1,5	0,7	3,0	1,0	14,2	0,9	0,6	0,8	0,2	
Sticky traps	Flying insects	>15mm	# individuals	2,3	1,7	0,3	0,0	0,3	0,0	0,7	0,0	1,0	1,5	2,0	0,0	1,3	1,0	1,0	1,7	0,0	14,8	1,1	0,6	0,8	0,2	
Sticky traps	Flying insects	all	# individuals	487,3	491,7	364,3	338,5	369,7	364,7	386,3	559,3	802,7	308,5	467,0	571,0	451,7	758,0	609,3	564,0	394,7		420,5	40,2	508,2	42,5	
sticky traps	Flying insects	0-1mm	Biomass (mg)	3,8	3,0	2,4	0,8	2,7	2,1	2,4	2,7	4,3	0,5	2,9	3,6	2,8	2,0	3,8	3,7	1,9	45,3	2,5	0,7	2,7	0,3	
sticky traps	Flying insects	1-2mm	Biomass (mg)	12,4	13,7	11,4	15,8	11,2	9,5	12,8	18,4	33,2	15,2	14,1	19,4	13,1	39,4	13,7	16,1	14,7	284,1	13,3	1,0	17,8	2,4	
sticky traps	Flying insects	2-3mm	Biomass (mg)	9,4	18,3	9,9	21,3	8,5	10,6	7,2	30,4	21,0	16,9	13,4	18,3	18,3	24,4	21,8	15,8	15,9	281,5	14,7	3,0	17,1	1,8	
sticky traps	Flying insects	3-4mm	Biomass (mg)	13,4	8,7	11,1	16,0	6,1	15,0	9,1	18,4	15,0	14,1	16,9	15,5	17,4	12,3	36,1	11,0	11,2	247,3	12,3	1,6	15,2	2,0	
sticky traps	Flying insects	4-5mm	Biomass (mg)	18,2	26,1	17,6	13,9	13,8	17,8	10,9	18,2	22,5	16,9	22,0	18,4	18,6	34,6	20,5	17,2	15,0	322,1	18,9	2,6	18,9	1,6	
sticky traps	Flying insects	5-6mm	Biomass (mg)	12,2	23,1	10,6	11,1	11,6	30,0	26,6	20,0	23,1	12,1	19,4	26,9	29,3	31,4	41,2	17,0	13,8	359,5	14,3	3,0	23,3	2,4	*
sticky traps	Flying insects	6-7mm	Biomass (mg)	29,3	34,0	22,5	48,0	31,8	58,8	46,8	44,8	76,4	58,7	33,2	48,0	62,6	76,6	101,2	53,7	25,8	852,2	33,4	5,4	55,3	5,8	*
sticky traps	Flying insects	7-8mm	Biomass (mg)	46,6	65,4	36,1	35,6	40,4	48,5	42,9	91,1	66,9	41,8	52,8	45,0	66,4	63,1	136,2	67,8	66,7	1013,4	45,9	7,0	63,8	7,3	
sticky traps	Flying insects	8-9mm	Biomass (mg)	28,5	75,0	19,9	15,6	35,5	46,1	52,2	66,3	57,8	52,4	30,4	40,7	77,3	100,3	86,5	62,5	44,3	891,3	34,7	13,7	57,9	5,7	
sticky traps	Flying insects	9-10mm	Biomass (mg)	32,1	70,1	21,8	35,7	21,5	58,3	40,1	29,7	70,3	51,5	19,0	25,1	41,8	56,9	52,2	58,5	56,1	740,9	40,0	10,5	44,7	4,6	
sticky traps	Flying insects	10-11mm	Biomass (mg)	13,6	37,1	9,2	21,5	10,4	46,7	28,7	41,5	37,9	13,6	18,7	23,5	29,5	81,7	34,4	17,9	48,2	514,3	20,4	6,1	33,3	5,3	
sticky traps	Flying insects	11-12mm	Biomass (mg)	0,0	52,1	0,0	0,0	12,1	18,5	42,0	18,5	43,0	26,5	6,0	11,6	37,6	72,6	18,3	44,2	17,8	420,5	13,0	13,0	28,3	5,2	
sticky traps	Flying insects	12-13mm	Biomass (mg)	29,6	22,8	0,0	0,0	7,0	23,7	0,0	6,9	22,2	23,1	24,2	7,7	0,0	78,5	0,0	54,0	23,4	323,2	13,1	7,7	20,8	6,4	
sticky traps	Flying insects	13-14mm	Biomass (mg)	10,0	45,5	17,9	26,6	9,6	38,7	28,5	17,4	38,3	28,2	19,2	27,6	0,0	110,0	29,5	66,6	0,0	513,8	25,0	7,6	31,8	8,1	
sticky traps	Flying insects	14-15mm	Biomass (mg)	34,4	90,0	0,0	0,0	0,0	21,9	47,3	10,8	11,3	0,0	46,2	0,0	12,0	52,2	22,1	103,9	34,8	486,7	31,1	21,3	27,9	8,1	
sticky traps	Flying insects	>15mm	Biomass (mg)	118,6	67,5	14,8	0,0	13,4	0,0	27,8	0,0	38,7	66,0	85,7	0,0	60,0	50,9	43,2	74,4	0,0	661,0	50,2	27,0	35,4	8,6	
sticky traps	Flying insects	all	Biomass (mg)	412,3	652,3	205,3	261,9	235,6	446,3	425,3	435,3	581,9	437,5	424,0	331,4	486,7	886,8	660,7	684,3	389,6		382,9	99,8	494,3	47,3	