Supplementary information: Macrolitter monitoring in terrestrial fields: from classification to source detection

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1. **Tables:**

Table S1: Excel format: All data and metadata used for statistical analysis.

Table S2: CSV format: Initial macroplastic classification sheet with Fieldcode, Date, ID_code, Litter_Type, Description, Quantity, Weight and Area.

Table S3: Excluded fields due to missing values in agricultural practices (compost, manure, plastic foil, pesticides or irrigation usage and tillage method).

Deleted fields
MC23_003
MC24_024
MC24_025
MC24_027
MC24_029
MC24_030
MC24_031
MC24_035
MC24_036
MC24_050
MC24_053
MC24_057
MC24_079
MC24_119
MC24_138
MC24_139
MC24_146
MC24_152
MC24_154
MC24_160
MC24_162
MC24_172
MC24_202
MC24_207
MC24_230
MC24_237
MC24_239

Table S4: Excluded field due to insufficient representation within the tillage category as only these fields did not apply any form of tillage.

Deleted fields
MC24_085
MC24_087
MC24_191
MC24_200

MC24_212
MC24_214

Table S5: Overview of mean litter count and mean litter weight of all litter, macro and mesolitter per category. The average amount and standard error of the mean of litter items in each category found throughout the fields per hectare for plastic, metals, rubber, glass, natural products, other and ceramics for all litter, macrolitter and mesolitter (n = 229 fields). The average weight (g) of litter items and standard error of the mean in each category found throughout the fields per hectare for plastic, metals, rubber, glass, natural products, other and ceramics for all litter, macrolitter and mesolitter (n = 229 fields).

Category	Size	Mean (items/ha)	SE	Mean (g/ha)	SE
Plastic	All litter	469.36	121.83	1008.45	184.11
Metal	All litter	11.89	5.97	146.87	47.69
Rubber	All litter	1.95	0.60	23.31	8.01
Glass	All litter	21.42	6.19	90.74	19.71
Natural products	All litter	3.38	1.28	19.52	12.17
Ceramics	All litter	78.09	11.62	623.25	84.37
Other	All litter	5.26	1.81	22.10	6.44
Plastic	Macro	215.31	65.71	850.76	157.64
Metal	Macro	3.62	0.47	107.69	41.60
Rubber	Macro	1.03	0.37	14.99	4.87
Glass	Macro	6.18	1.99	65.77	21.88
Natural products	Macro	1.92	0.58	12.80	5.02
Ceramics	Macro	21.96	2.66	474.55	58.10
Other	Macro	3.21	0.93	26.37	9.61
Plastic	Meso	254.60	81.68	90.97	37.75
Metal	Meso	8.26	5.95	4.54	2.81
Rubber	Meso	0.93	0.46	0.52	0.25
Glass	Meso	15.27	4.40	31.77	9.09
Natural products	Meso	1.49	0.82	0.79	0.52
Ceramics	Meso	56.15	9.32	141.14	29.04
Other	Meso	2.09	1.04	0.92	0.49

Table S6: Overview of polymertype composition. The polymer type of 706 items of litter measured using ATR-FTIR. The number of particles measured within the polymertype and the percentage of the polymertype.

Polymertype	Number (n)	Pecentage (%)
ABS	2	0.2832861
CAB	1	0.1416431
EVA	19	2.6912181
Nitril	1	0.1416431
Nylon	2	0.2832861
Nylon 6_6	6	0.8498584

PBT	2	0.2832861
PE	319	45.1841360
PES	3	0.4249292
PET	15	2.1246459
PMMA	6	0.8498584
PP	200	28.3286119
PS	43	6.0906516
PU	5	0.7082153
PVC	76	10.7648725
Poly (diallyl isophthalate)	1	0.1416431
Polyester	1	0.1416431
Polyesterurethane	2	0.2832861
Silicone	1	0.1416431
Styrene acrylonitrile	1	0.1416431
Total	**706**	**100.0**

Table S7: The average amount of all litter, macro- and mesoplastic items in each plastic subcategory found throughout the fields per hectare with the standard error of the mean.

Subcategory	Subcategory number	Size	Mean (items/ha)	SE
Bottle	A1	All litter	0.53	0.17
Sheet	A2	All litter	330.59	103.85
Bag	A3	All litter	2.58	0.50
Caps and lids	A4	All litter	3.76	1.88
Monofilament	A5	All litter	7.47	4.09
Entangled monofilament	A6	All litter	8.13	2.99
Synthetic rope	A7	All litter	1.78	0.48
Plastic tags	A8	All litter	0.63	0.15
Cable ties	A9	All litter	1.09	0.78
Strapping band	A10	All litter	0.33	0.15
Crates and containers	A11	All litter	1.15	0.37
Sanitary products	A12	All litter	0.05	0.04
Plastic construction material	A13	All litter	3.17	0.88
Other	A14	All litter	4.81	1.37
Medical related plastic	A15	All litter	1.46	0.67
Plastic irrigation pipes	A16	All litter	0.41	0.18
Hard plastics	A17	All litter	77.55	23.49
Plastic shotgun cartridges	A18	All litter	0.65	0.18
Fragments of foamed plastic	A19	All litter	5.92	3.43
Crisp packets/sweet wrappers	A20	All litter	11.70	1.98
Plastic stickers	A21	All litter	6.26	2.56
Bottle	A1	Macro	0.53	0.20
Sheet	A2	Macro	172.17	64.81
Bag	A3	Macro	2.48	0.49
Caps and lids	A4	Macro	1.14	0.27

Monofilament	A5	Macro	0.21	0.14
Entangled monofilament	A6	Macro	1.82	0.40
Synthetic rope	A7	Macro	1.33	0.44
Plastic tags	A8	Macro	0.52	0.13
Cable ties	A9	Macro	0.29	0.11
Strapping band	A10	Macro	0.31	0.15
Crates and containers	A11	Macro	1.04	0.35
Sanitary products	A12	Macro	0.05	0.04
Plastic construction material	A13	Macro	2.68	0.82
Other	A14	Macro	2.45	0.44
Medical related plastic	A15	Macro	0.36	0.14
Plastic irrigation pipes	A16	Macro	0.41	0.18
Hard plastics	A17	Macro	16.95	2.10
Plastic shotgun cartridges	A18	Macro	0.65	0.18
Fragments of foamed plastic	A19	Macro	1.29	0.45
Crisp packets/sweet wrappers	A20	Macro	7.29	1.39
Plastic stickers	A21	Macro	1.32	0.51
Bottle	A1	Meso	0.00	0.00
Sheet	A2	Meso	158.39	54.81
Bag	A3	Meso	0.09	0.06
Caps and lids	A4	Meso	2.61	1.83
Monofilament	A5	Meso	7.26	4.09
Entangled monofilament	A6	Meso	6.27	2.93
Synthetic rope	A7	Meso	0.45	0.21
Plastic tags	A8	Meso	0.11	0.07
Cable ties	A9	Meso	0.80	0.77
Strapping band	A10	Meso	0.01	0.01
Crates and containers	A11	Meso	0.12	0.07
Sanitary products	A12	Meso	0.00	0.00
Plastic construction material	A13	Meso	0.50	0.28
Other	A14	Meso	2.36	1.07
Medical related plastic	A15	Meso	1.09	0.66
Plastic irrigation pipes	A16	Meso	0.00	0.00
Hard plastics	A17	Meso	60.59	22.52
Plastic shotgun cartridges	A18	Meso	0.00	0.00
Fragments of foamed plastic	A19	Meso	4.62	3.37
Crisp packets/sweet wrappers	A20	Meso	4.40	1.00
Plastic stickers	A21	Meso	4.93	2.49

2. Figures:

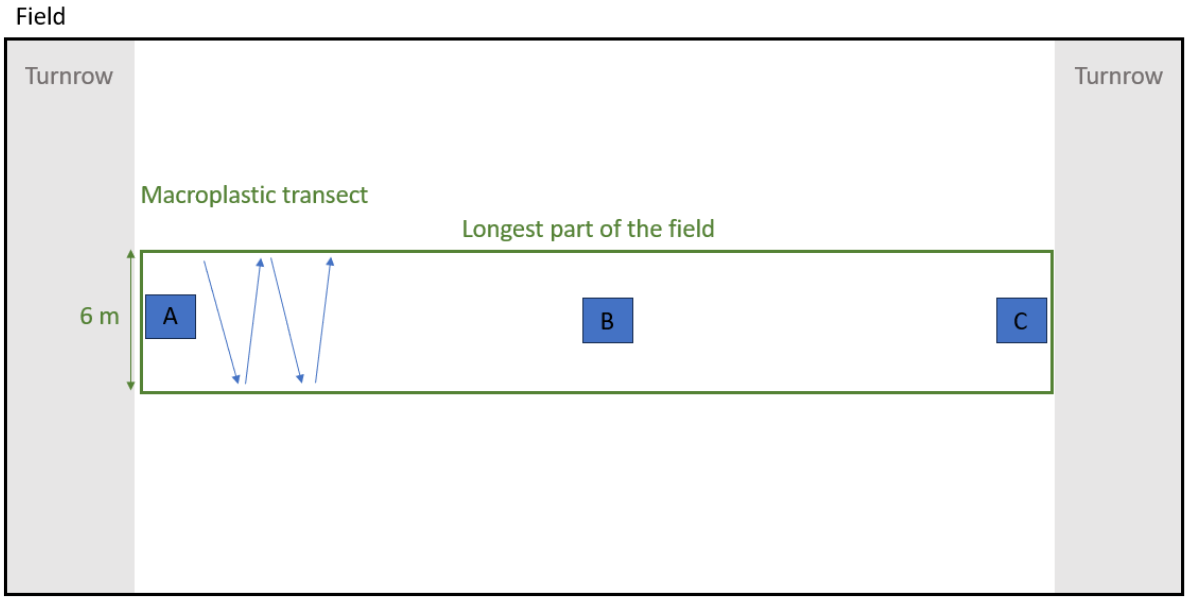

Figure S1: Schematic drawing of the agricultural field with length specifications. The samples were taken by walking along the blue arrows (zig-zag pattern) and collecting all visible macrolitter. A transect (green) of the longest central part of the field was sampled, by starting after and ending before the turnrows (grey) of the two sides of the field. The sampling area was taken with a width of six meters. The coordinates of the starting (A), middle (B) and end (C) point were taken with a WGS-84 system, to calculate the sampling area, accounting for a sampling width of 6 m.

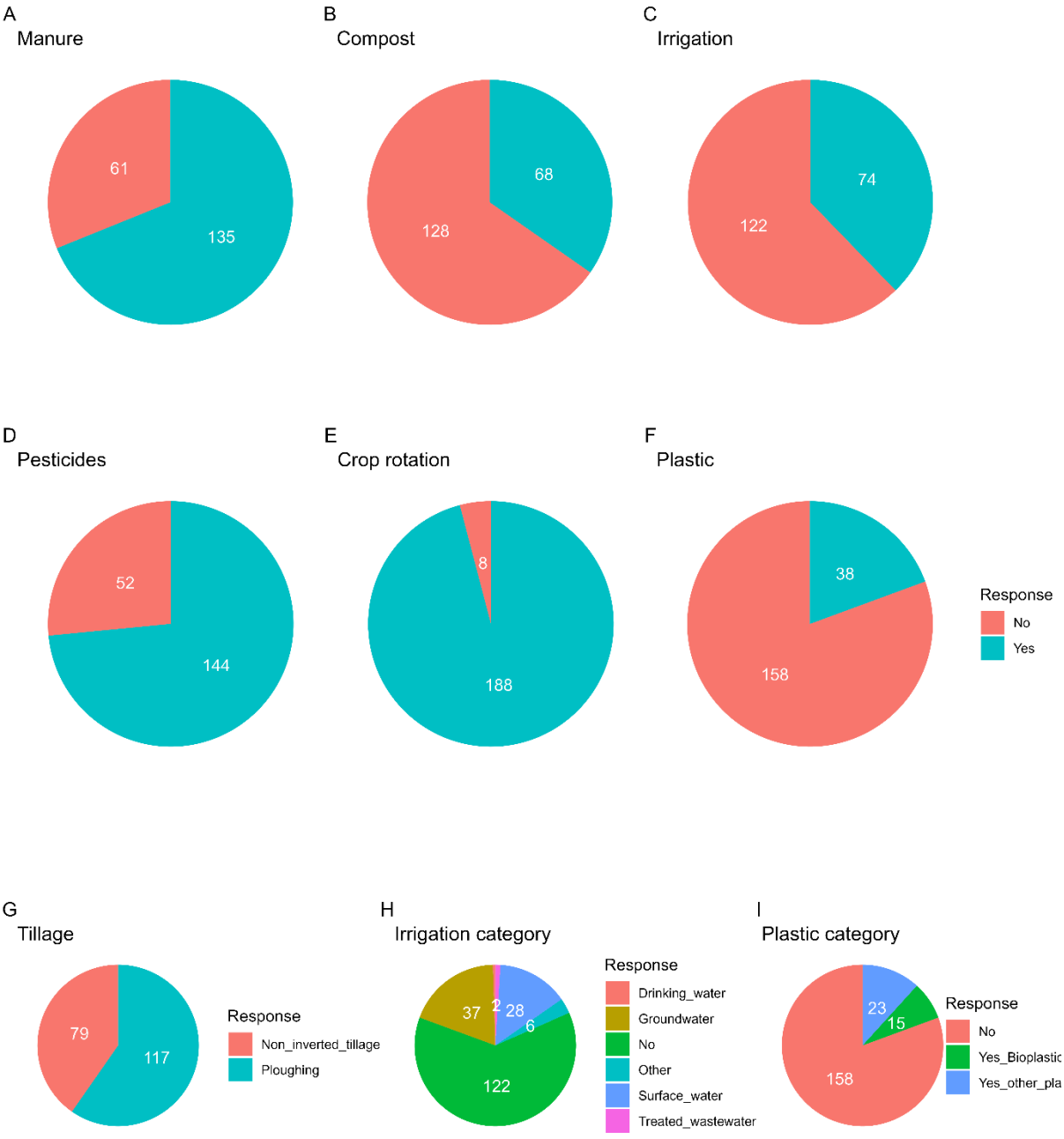

Figure S2: Amount of fields within each field management type. The total of the fields within each field management type (A-Compost, B-Manure, C-Pesticides, D-Crop rotation, E-Irrigation, F-Usage of plastic foil and G-Tillage). Total amount of fields: n = 196. Yes = green, no is red.

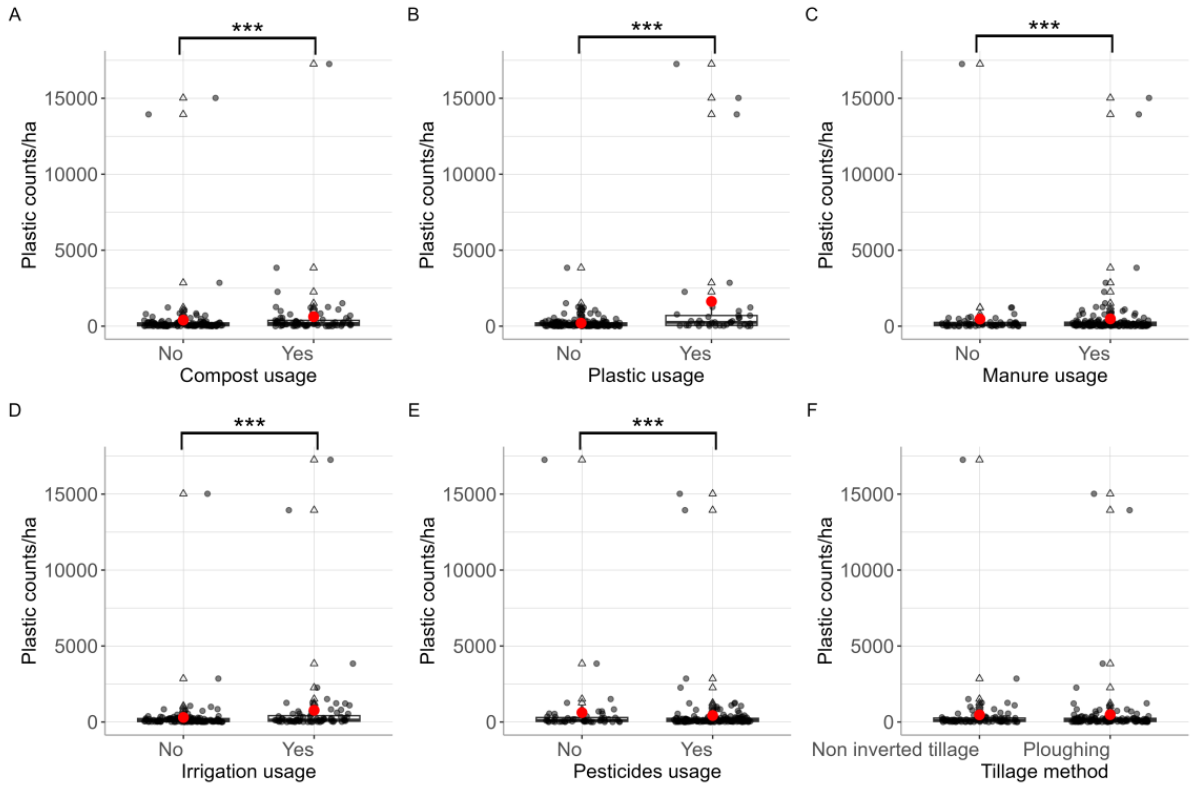

Figure S3: Boxplot total plastic count per hectare in interaction with tillage and other field management types. The plots show the raw data counts per hectare. A) the usage of compost. B) the usage of plastic foil on the field. C) the usage of manure on the field. D) application of irrigation on the field. E) the usage of pesticides on the field. F) the usage of tillage with non-inverted tillage and ploughing. Grey dots represent the datapoints of each field. Outliers are indicated with a triangle. Statistical analyses with negative binomial model including anova and post-hoc testing using general linear hypothesis testing with custom contrasts. The mean is indicated with a red dot. A line denotes a significant differences between usages of field management. Asterisk (*) denotes the significant level '***' $P < 0.001$, '**' $P < 0.01$, '*' $P < 0.05$, '.' $P < 0.1$. n = 196.

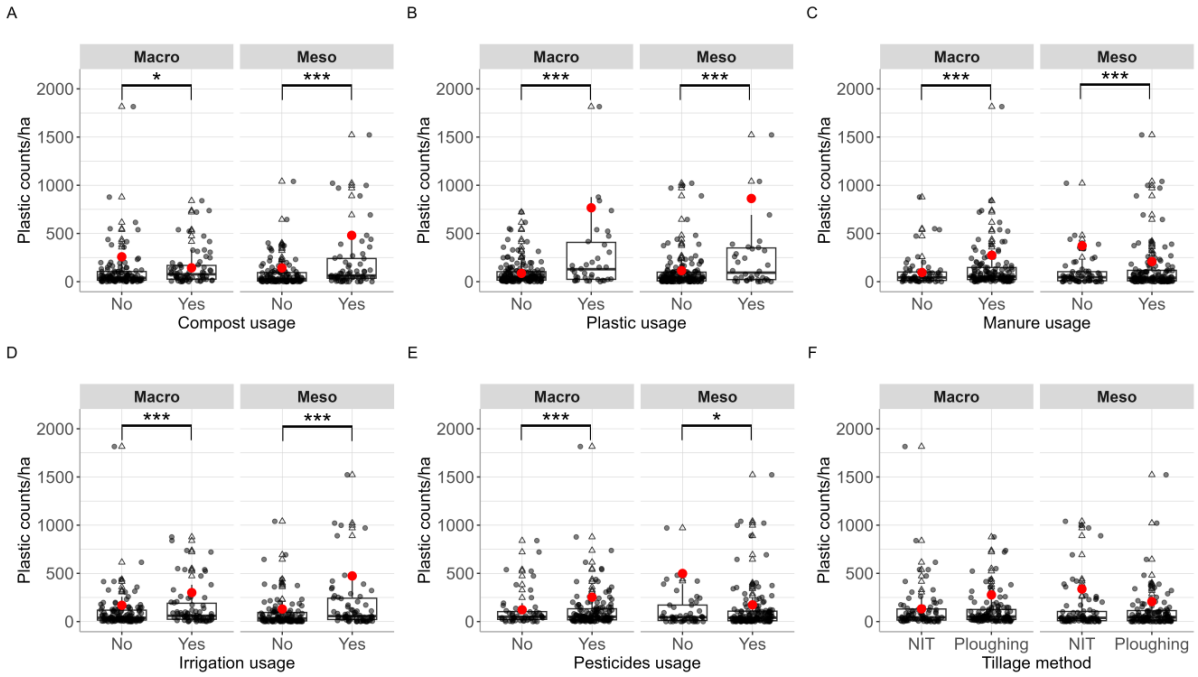

Figure S4: Boxplots macro and mesoplastics count per hectare in interaction with tillage and other field management types. The plots show the raw data between 0 and 2000 counts per hectare. A) the usage of compost. Fields above 2000 items/ha, for macro: No: 2, Yes: 0, for meso: No: 2, Yes: 2. B) the usage of plastic foil on the field. Fields above 2000 items/ha, for macro: No: 0, Yes: 2, for meso: No: 1, Yes: 3. C) the usage of manure on the field. Fields above 2000 items/ha, for macro: No: 0, Yes: 2, for meso: No: 1, Yes: 3. D) application of irrigation on the field. Fields above 2000 items/ha, for macro: No: 1, Yes: 1, for meso: No: 1, Yes: 3. E) the usage of pesticides on the field. Fields above 2000 items/ha, for macro: No: 0, Yes: 2, for meso: No: 2, Yes: 2. F) the usage of tillage with non-inverted tillage and ploughing. Fields above 2000 items/ha, for macro: No: 0, Yes: 2, for meso: No: 1, Yes: 3. Grey dots represent the datapoints of each field. Outliers are indicated with a triangle. Statistical analyses with negative binomial model including anova and post-hoc testing using general linear hypothesis testing with custom contrasts. The mean is indicated with a red dot. A line denotes a significant differences between usages of field management. Asterisk (*) denotes the significant level '***' $P < 0.001$, '**' $P < 0.01$, '*' $P < 0.05$, '.' $P < 0.1$. n = 196.

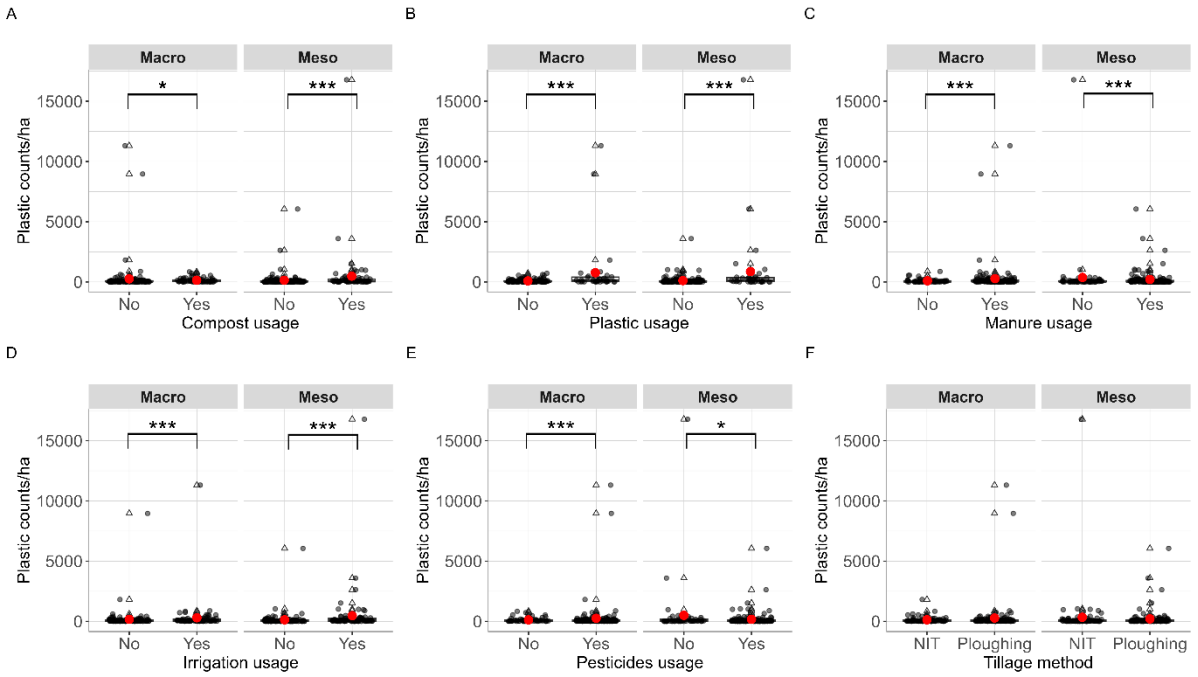

Figure S5: Boxplots macro and mesoplastics count per hectare in interaction with tillage and other field management types. The plots show the raw data counts per hectare. A) the usage of compost. B) the usage of plastic foil on the field. C) the usage of manure on the field. D) application of irrigation on the field. E) the usage of pesticides on the field. F) the usage of tillage with non-inverted tillage and ploughing. Grey dots represent the datapoints of each field. Outliers are indicated with a triangle. Statistical analyses with negative binomial model including anova and post-hoc testing using general linear hypothesis testing with custom contrasts. The mean is indicated with a red dot. A line denotes a significant differences between usages of field management. Asterisk (*) denotes the significant level '***' $P < 0.001$, '**' $P < 0.01$, '*' $P < 0.05$, '.' $P < 0.1$. n = 196.

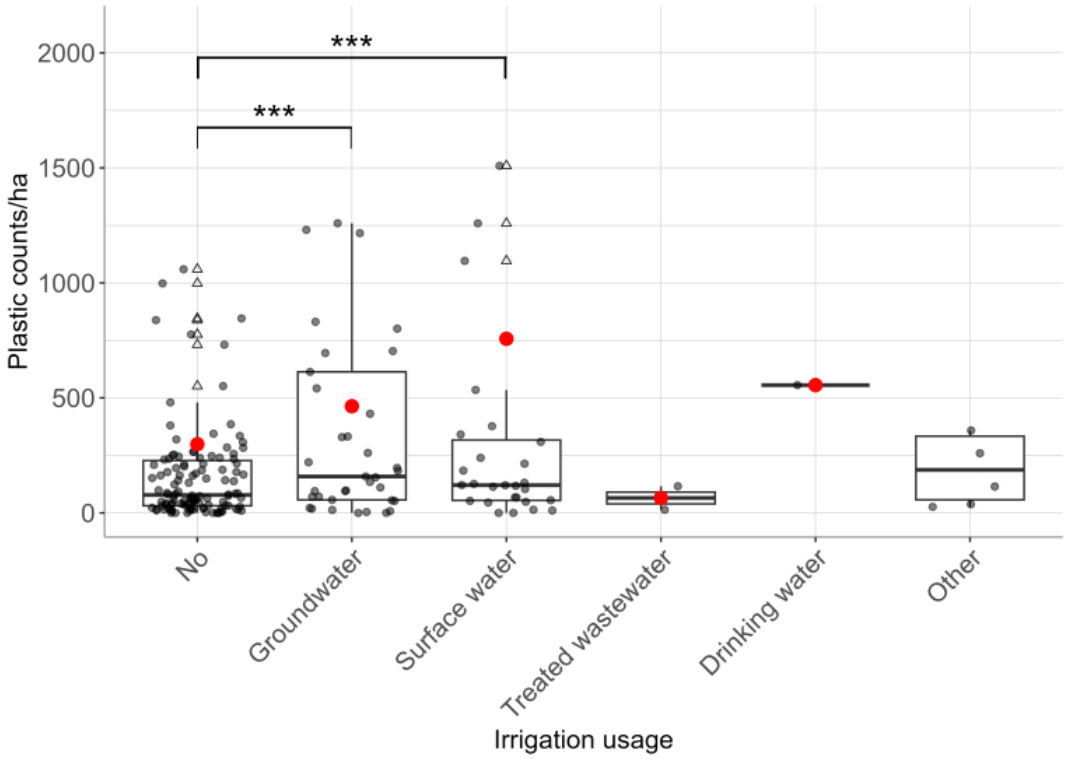

Figure S6: The number of plastic items/ha with the use of different irrigation sources. The plots show the raw data between 0 and 2000 counts per hectare of plastic items. The categories 'Groundwater' and 'No' have 2 fields with a plastic items/ha above 2000, the categories 'Surface water' and 'Other' have one field with a plastic count above 2000. Grey dots represent the datapoints of each field. Statistical analyses with negative binomial model including Anova and post-hoc testing using general linear hypothesis testing with custom contrast. Statistical analyses was not performed on Treated wastewater, drinking water and others due to not enough datapoints. Outliers are indicated with a triangle. The mean is indicated with a red dot. A line denotes a significant differences between no usage or usage of field management. Asterisk (*) denotes the significant level '***' $P < 0.001$, '**' $P < 0.01$, '*' $P < 0.05$, '.' $P < 0.1$. n = 196.

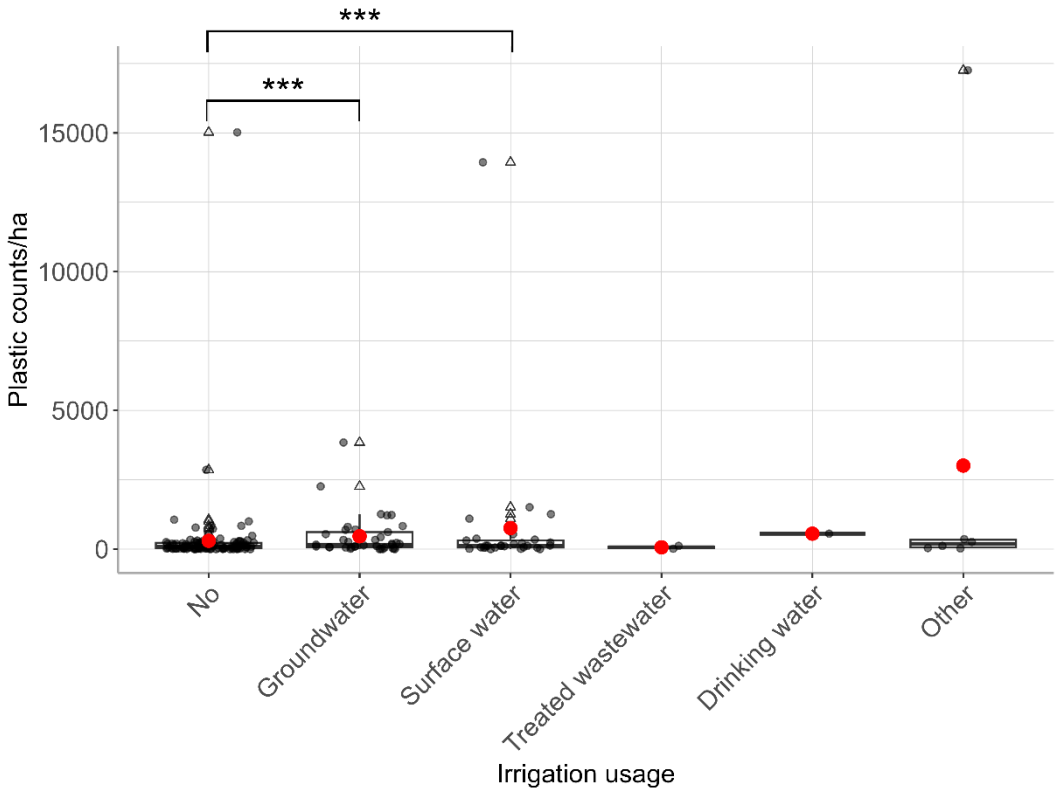

Figure S7: The number of plastic items/ha with the use of different irrigation sources. The plots represent the rqz data of the plastic counts/ha of the irrigation sources: Drinking water, Groundwater, No irrigation, Other, Surface water and treated wastewater. Grey dots represent the datapoints of each field. Statistical analyses with negative binomial model including Anova and post-hoc testing using general linear hypothesis testing with custom contrast. Statistical analyses was not performed on Treated wastewater, drinking water and others due to not enough datapoints. Outliers are indicated with a triangle. The mean is indicated with a red dot. A line denotes a significant differences between no usage or usage of field management. Asterisk (*) denotes the significant level '***' $P < 0.001$, '**' $P < 0.01$, '*' $P < 0.05$, '.' $P < 0.1$. n = 196.

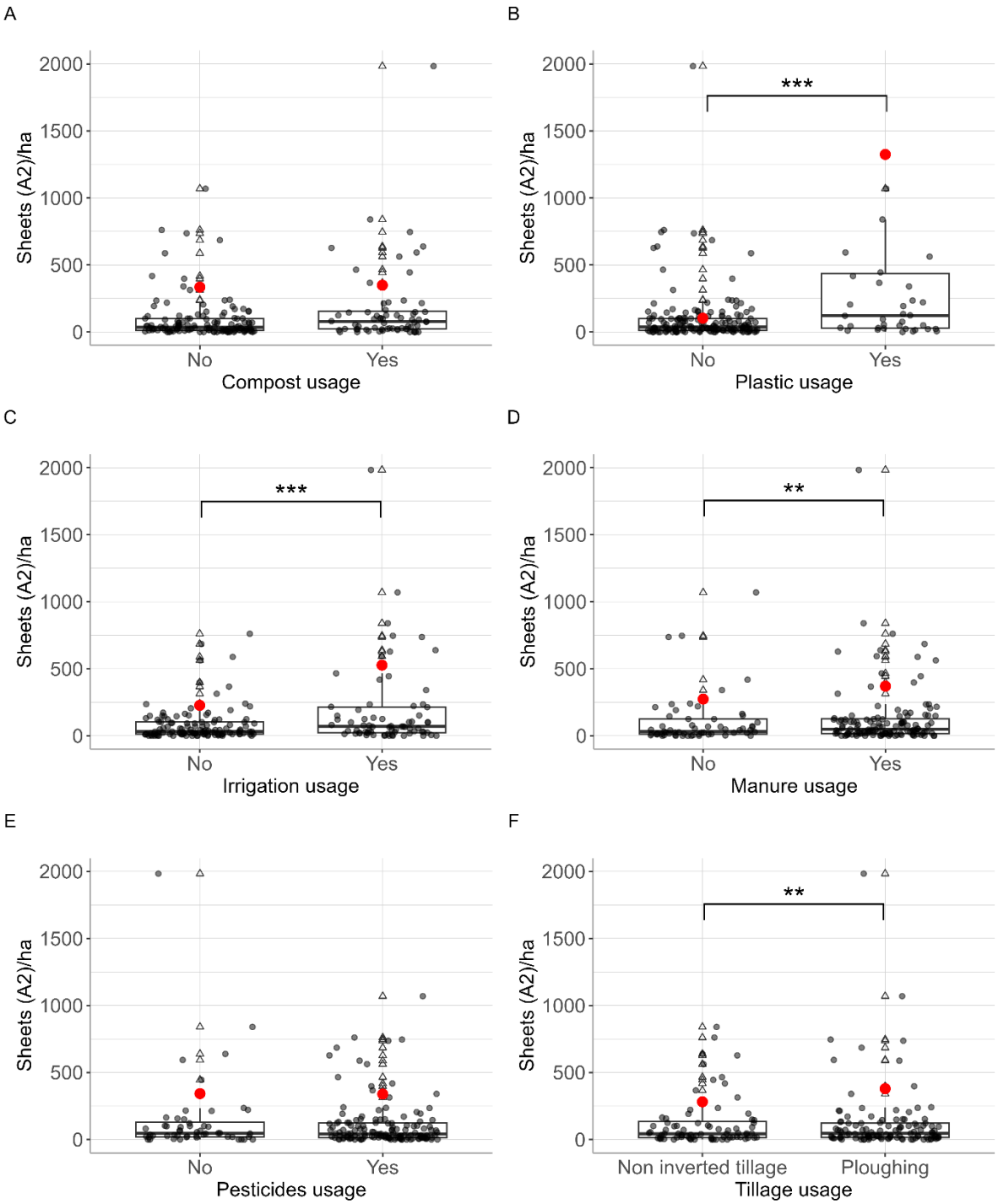

Figure S8: Plastic sheets/ha in combination with field management practices. The plots show the raw data between 0 and 2000 counts per hectare of plastic sheets (A2). A) the usage of compost. Fields above 2000 items/ha, No: 3, Yes: 2. B) the usage of plastic foil on the field. Fields above 2000 items/ha, No: 0, Yes: 5. C) the usage of irrigation on the field. Fields above 2000 items/ha, No: 2, Yes: 3. D) application of manure on the crops/field. Fields above 2000 items/ha, No: 1, Yes: 1. E) the usage of pesticides on the field. Fields above 2000 items/ha, No: 1, Yes: 4. F) The use of tillage: non-inverted tillage (NIT) and ploughing. Fields above 2000 items/ha, NIT: 2, Ploughing: 3. Grey dots represent the datapoints of each field. Statistical analyses with negative binomial model including anova and post-hoc testing using general linear hypothesis testing with custom contrast. Outliers are indicated with a triangle. The mean is indicated with a red dot. A line denotes a significant differences between no usage or usage of field management. Asterisk (*) denotes the significant level '***' $P < 0.001$, '**' $P < 0.01$, '*' $P < 0.05$, '.' $P < 0.1$. n = 196.

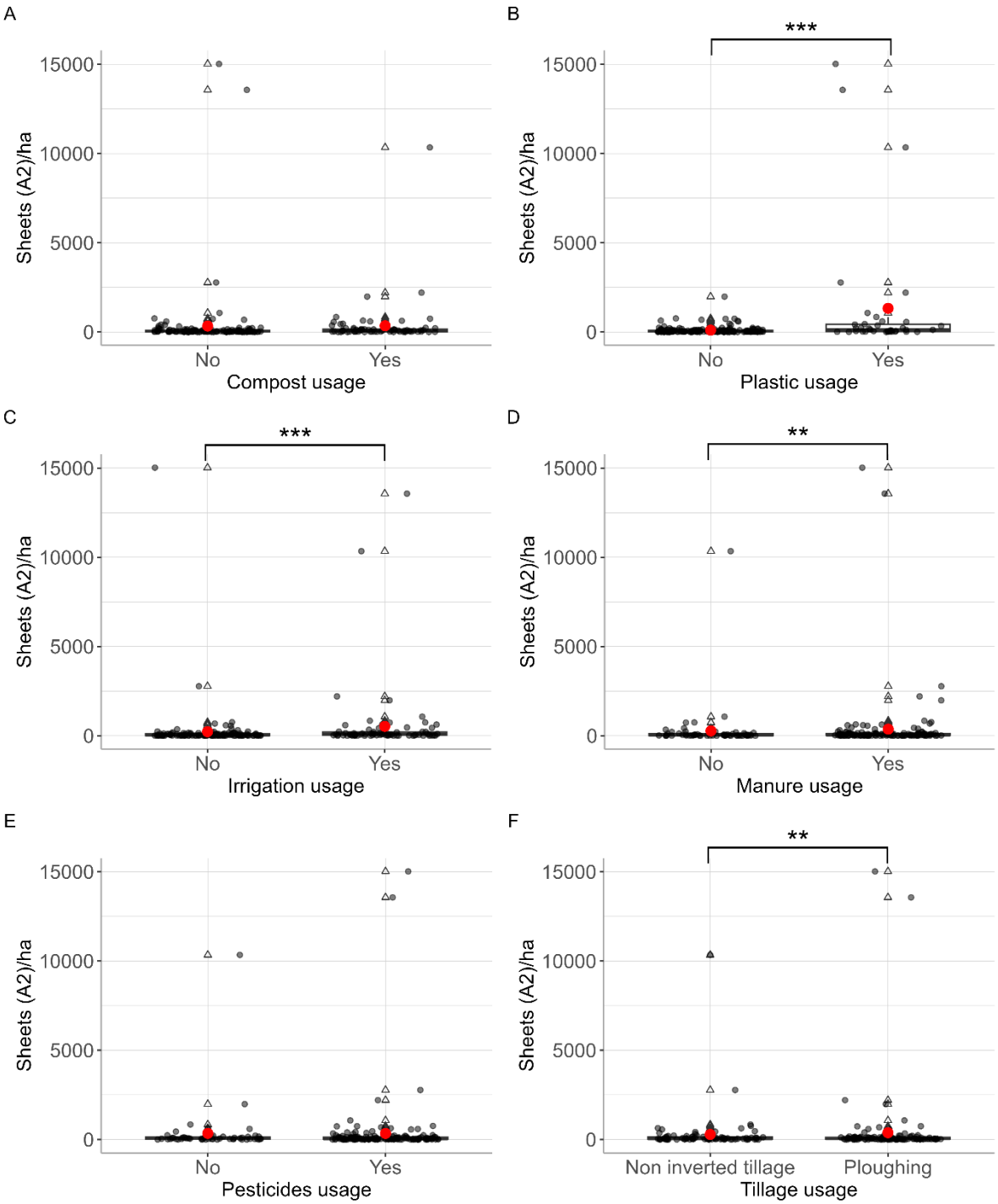

Figure S9: Plastic sheets/ha in combination with field management practices. The plots show the raw data of plastic sheets (A2). A) the usage of compost. B) the usage of plastic foil on the field. C) the usage of irrigation on the field. D) application of manure on the crops/field. E) the usage of pesticides on the field. F) The use of tillage: non-inverted tillage and ploughing. Grey dots represent the datapoints of each field. Statistical analyses with negative binomial model including anova and post-hoc testing using general linear hypothesis testing with custom contrast. Outliers are indicated with a triangle. The mean is indicated with a red dot. A line denotes a significant differences between no usage or usage of field management. Asterisk (*) denotes the significant level '***' $P < 0.001$, '**' $P < 0.01$, '*' $P < 0.05$, '.' $P < 0.1$. n = 196.

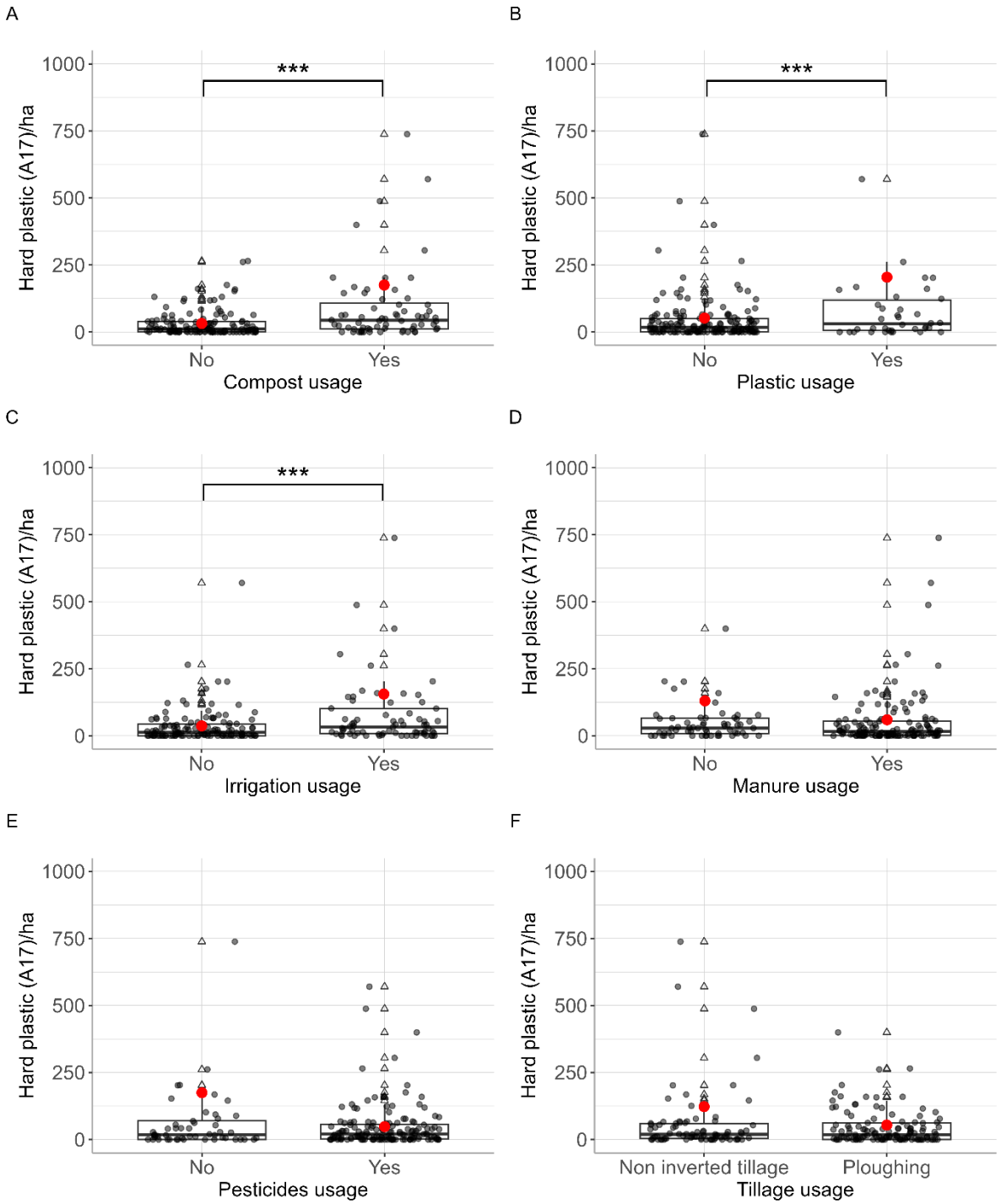

Figure S10: The number of hard plastics/ha in combination with field management practices. The plots show the raw data between 0 and 1000 counts per hectare of hard plastics (A17). A) the usage of compost. Fields above 1000 items/ha, No: 0, Yes: 2. B) the usage of plastic foil on the field. Fields above 1000 items/ha, No: 1, Yes: 1. C) the usage of irrigation on the field. Fields above 1000 items/ha, No: 0, Yes: 2. D) application of manure on the crops/field. Fields above 1000 items/ha, No: 1, Yes: 1. E) the usage of pesticides on the field. Fields above 1000 items/ha, No: 2, Yes: 0. F) The use of tillage: non-inverted tillage (NIT) and ploughing. Fields above 1000 items/ha, NIT: 1, Ploughing: 1. Grey dots represent the datapoints of each field. Statistical analyses with negative binomial model including anova and post-hoc testing using general linear hypothesis testing with custom contrast. Outliers are indicated with a triangle. The mean is indicated with a red dot. A line denotes a significant differences between no usage or usage of field management. Asterisk (*) denotes the significant level '***' $P < 0.001$, '**' $P < 0.01$, '*' $P < 0.05$, '.' $P < 0.1$. n = 196.

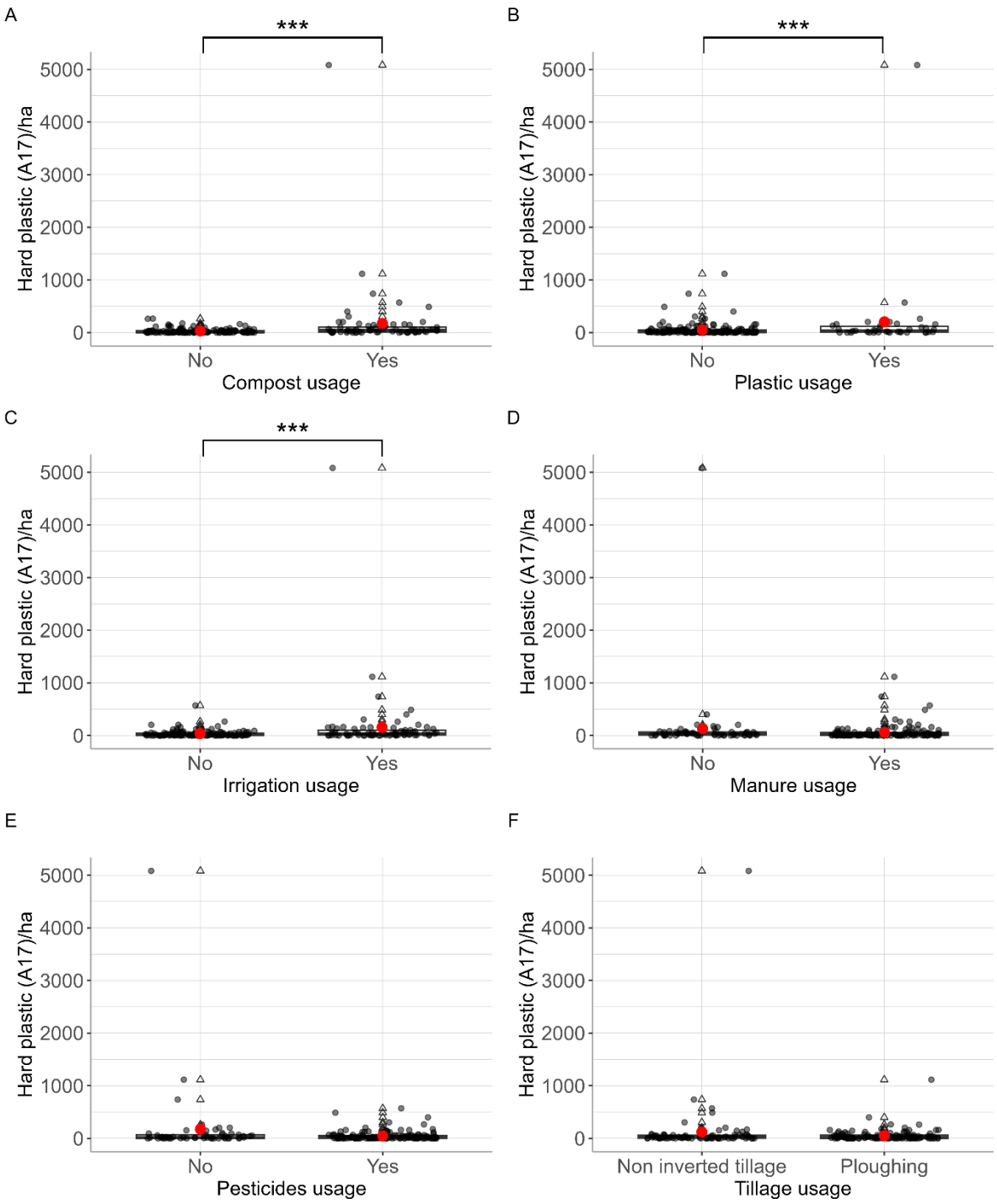

Figure S11: The number of hard plastics/ha in combination with field management practices. The plots show the raw data per hectare of hard plastics (A17). A) the usage of compost. B) the usage of plastic foil on the field. C) the usage of irrigation on the field. D) application of manure on the crops/field. E) the usage of pesticides on the field. F) The use of tillage: non-inverted tillage and ploughing. Grey dots represent the datapoints of each field. Statistical analyses with negative binomial model including anova and post-hoc testing using general linear hypothesis testing with custom contrast. Outliers are indicated with a triangle. The mean is indicated with a red dot. A line denotes a significant differences between no usage or usage of field management. Asterisk (*) denotes the significant level '***' $P < 0.001$, '**' $P < 0.01$, '*' $P < 0.05$, '.' $P < 0.1$. n = 196.

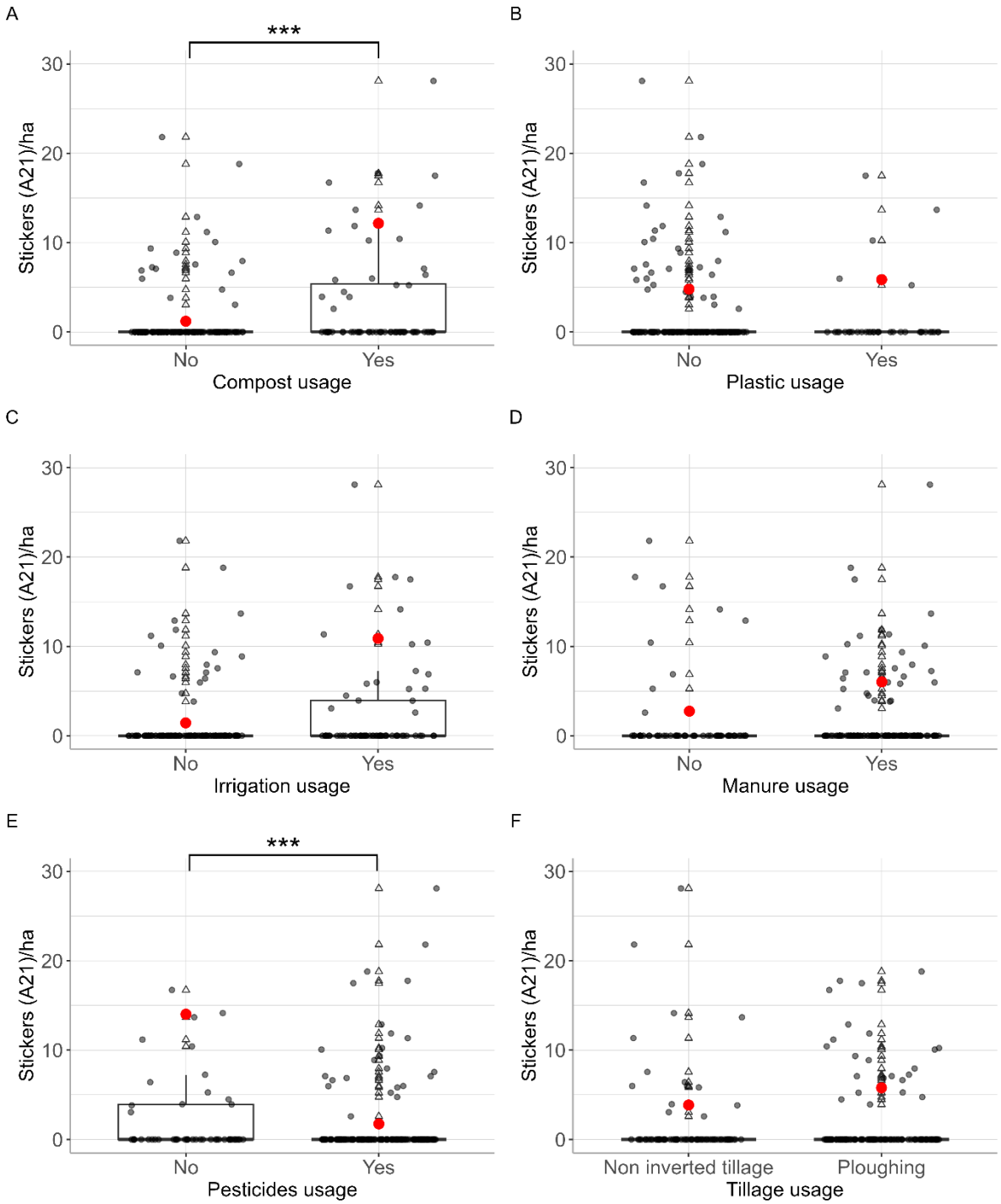

Figure S12: The number of plastic stickers/ha in combination with field management practices. The plots show the raw data between 0 and 30 counts per hectare of plastic stickers (A21). A) the usage of compost. Fields above 30 items/ha, No: 0, Yes: 3. B) the usage of plastic foil on the field. Fields above 30 items/ha, No: 1, Yes: 2. C) the usage of irrigation on the field. Fields above 30 items/ha, No: 0, Yes: 3. D) application of manure on the crops/field. Fields above 30 items/ha, No: 1, Yes: 2. E) the usage of pesticides on the field. Fields above 30 items/ha, No: 3, Yes: 0. F) The use of tillage: non-inverted tillage (NIT) and ploughing. Fields above 30 items/ha, NIT: 2, Ploughing: 1. Grey dots represent the datapoints of each field. Statistical analyses with negative binomial model including anova and post-hoc testing using general linear hypothesis testing with custom contrast. Outliers are indicated with a triangle. The mean is indicated with a red dot. A line denotes a significant differences between no usage or usage of field management. Asterisk (*) denotes the significant level '***' $P < 0.001$, '**' $P < 0.01$, '*' $P < 0.05$, '.' $P < 0.1$. n = 196.

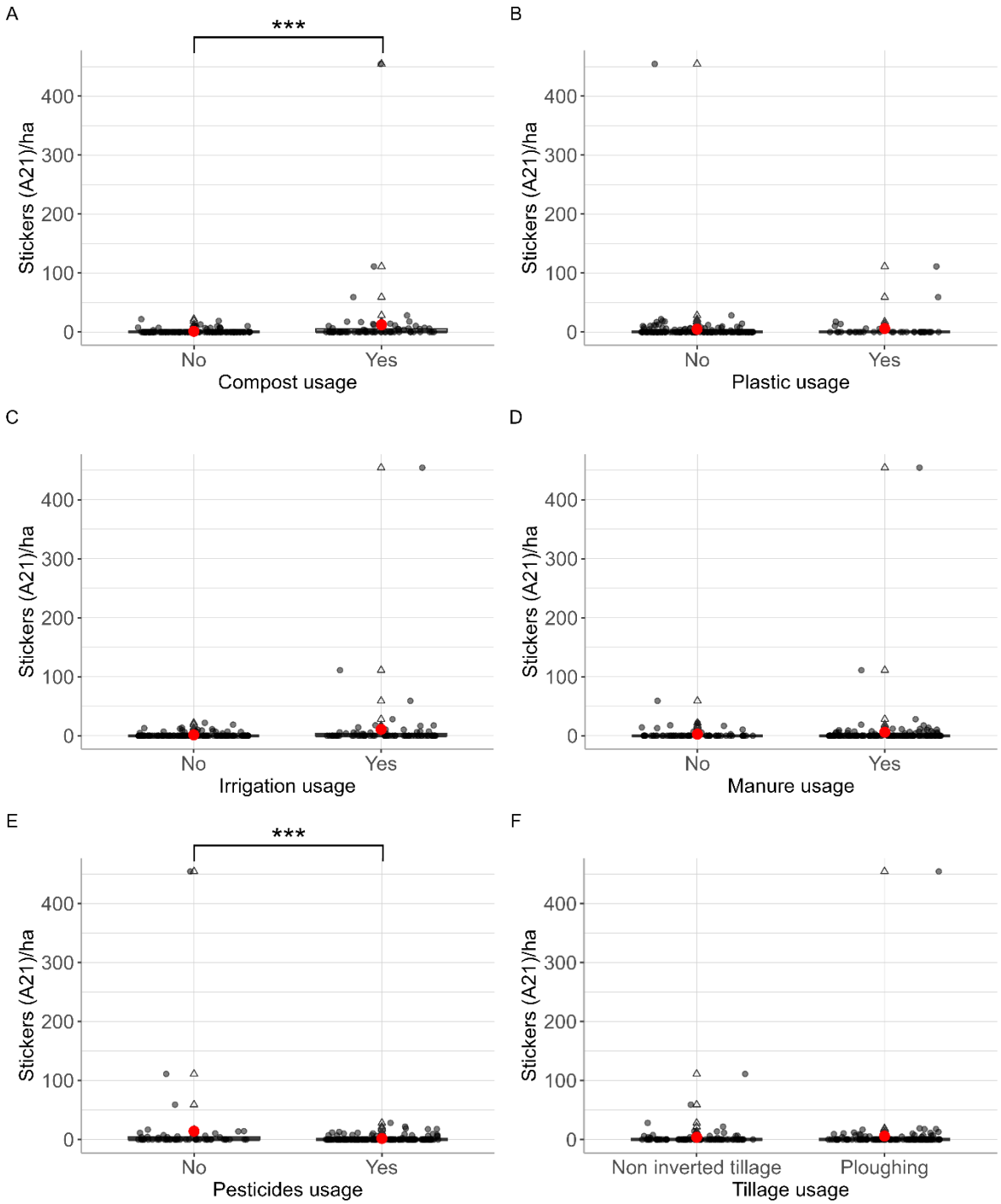

Figure S13: The number of plastic stickers/ha in combination with field management practices. The plots show the raw data per hectare of plastic stickers (A21). A) the usage of compost. B) the usage of plastic foil on the field. C) the usage of irrigation on the field. D) application of manure on the crops/field. E) the usage of pesticides on the field. F) The use of tillage: non-inverted tillage and ploughing. Grey dots represent the datapoints of each field. Statistical analyses with negative binomial model including anova and post-hoc testing using general linear hypothesis testing with custom contrast. Outliers are indicated with a triangle. The mean is indicated with a red dot. A line denotes a significant differences between no usage or usage of field management. Asterisk (*) denotes the significant level '***' $P < 0.001$, '**' $P < 0.01$, '*' $P < 0.05$, '.' $P < 0.1$. n = 196.

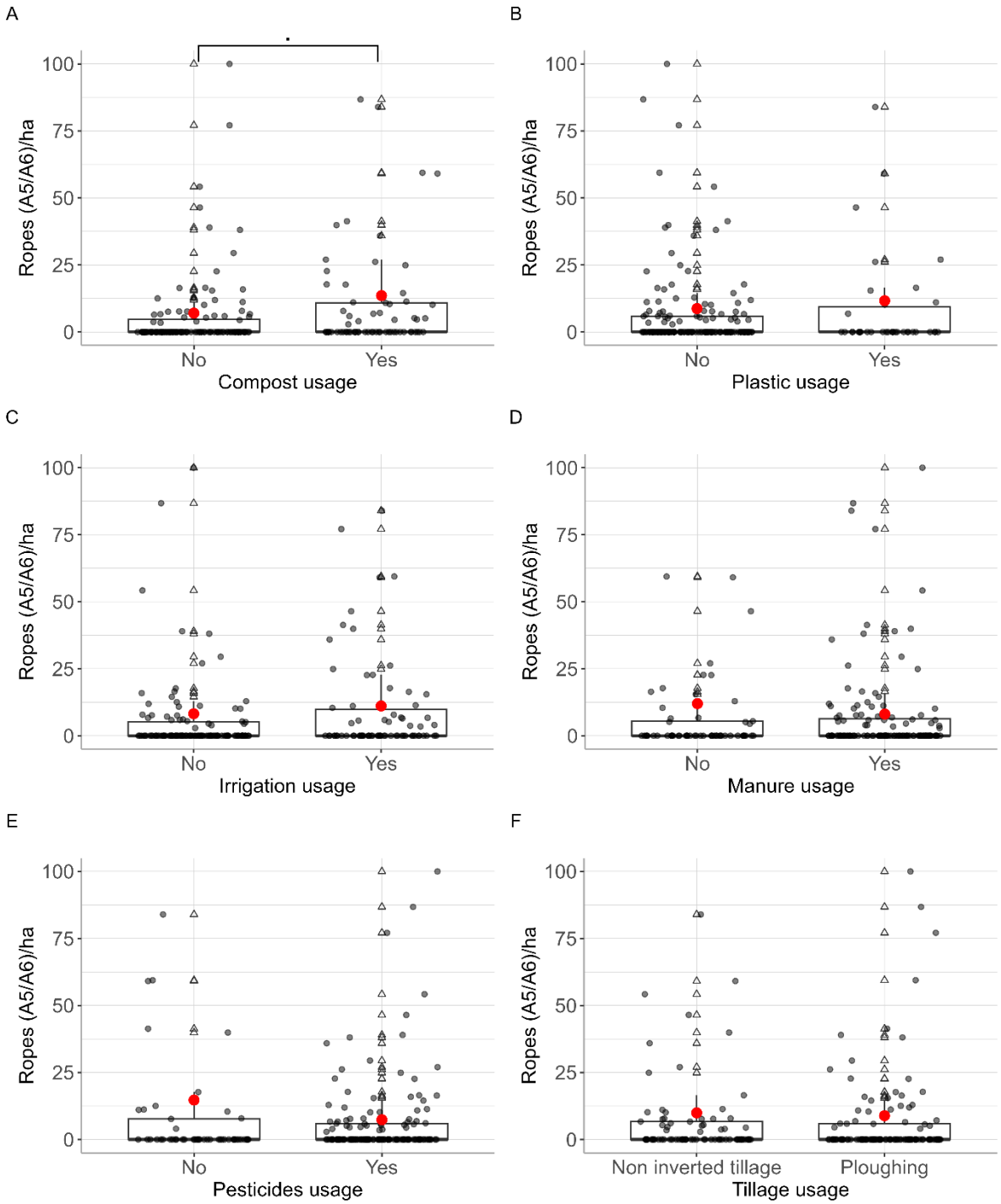

Figure S14: The number of plastic ropes/ha in combination with field management practices. The plots show the raw data between 0 and 100 counts per hectare of plastic ropes (A5 and A6). A) the usage of compost. Fields above 100 items/ha, No: 2, Yes: 1. B) the usage of plastic foil on the field. Fields above 100 items/ha, No: 2, Yes: 1. C) the usage of irrigation on the field. Fields above 100 items/ha, No: 2, Yes: 1. D) application of manure on the crops/field. Fields above 100 items/ha, No: 2, Yes: 1. E) the usage of pesticides on the field. Fields above 100 items/ha, No: 2, Yes: 1. F) The use of tillage: non-inverted tillage (NIT) and ploughing. Fields above 30 items/ha, NIT: 1, Ploughing: 2. Grey dots represent the datapoints of each field. Statistical analyses with negative binomial model including Anova and post-hoc testing using general linear hypothesis testing with custom contrast. Outliers are indicated with a triangle. The mean is indicated with a red dot. A line denotes a significant differences between no usage or usage of field management. Asterisk (*) denotes the significant level '***' $P < 0.001$, '**' $P < 0.01$, '*' $P < 0.05$, '.' $P < 0.1$. n = 196.

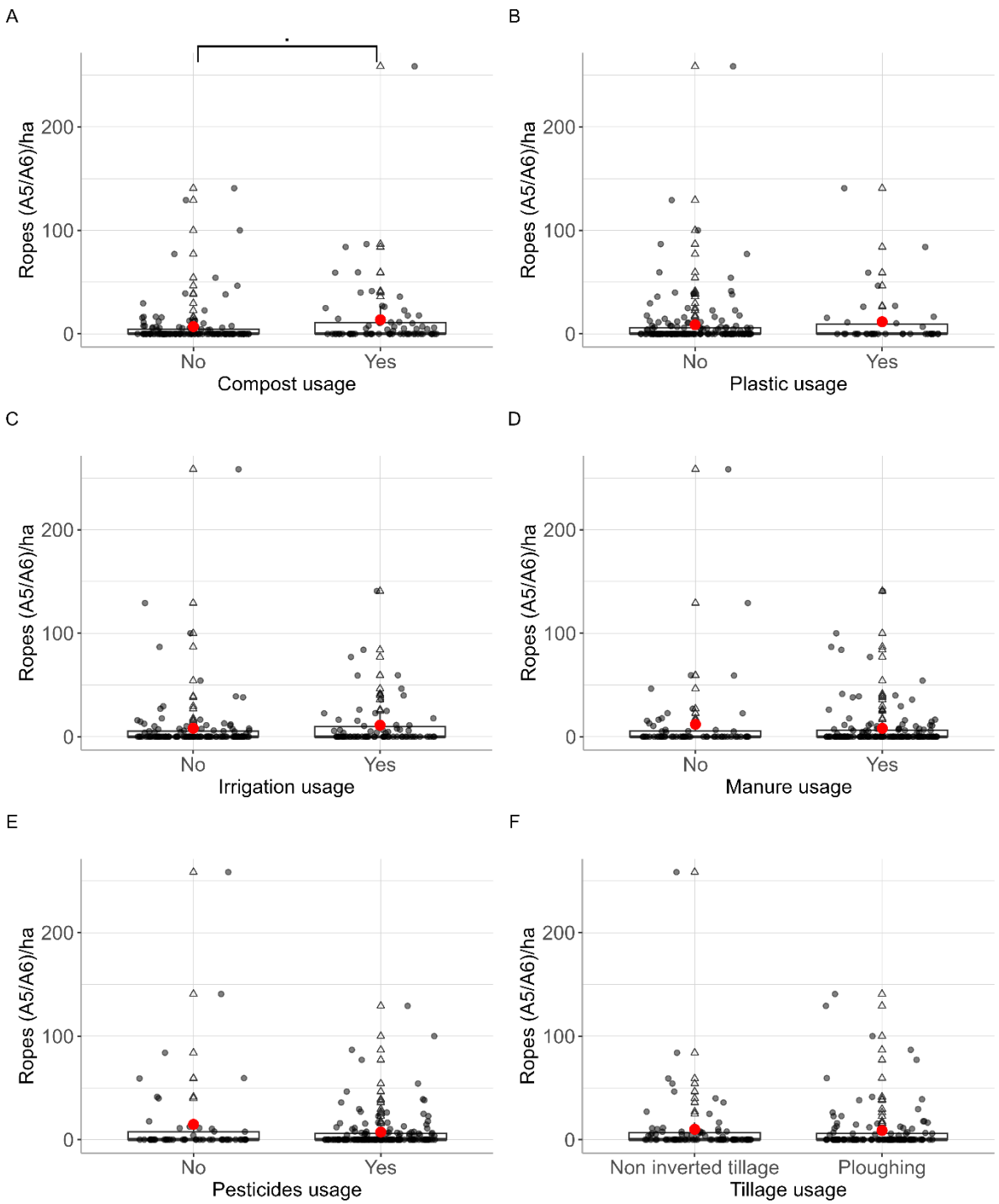

Figure S15: The number of plastic ropes/ha in combination with field management practices. The plots show the raw data between 0 and 100 counts per hectare of plastic ropes (A5 and A6). A) the usage of compost. B) the usage of plastic foil on the field. C) the usage of irrigation on the field. D) application of manure on the crops/field. E) the usage of pesticides on the field. F) The use of tillage: non-inverted tillage and ploughing. Grey dots represent the datapoints of each field. Statistical analyses with negative binomial model including Anova and post-hoc testing using general linear hypothesis testing with custom contrast. Outliers are indicated with a triangle. The mean is indicated with a red dot. A line denotes a significant differences between no usage or usage of field management. Asterisk (*) denotes the significant level '***' $P < 0.001$, '**' $P < 0.01$, '*' $P < 0.05$, '.' $P < 0.1$. n = 196.

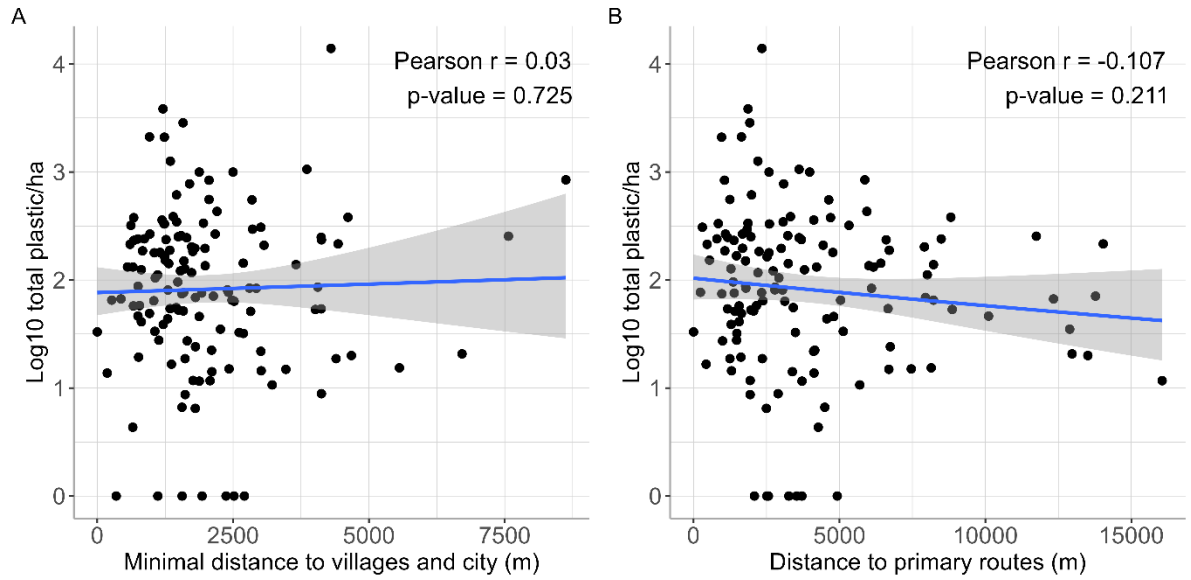

Figure S16: Correlation between the minimal distance of the field to villages and cities and primary routes and the log10 of total plastic items/ha in Belgium. A) Pearson's correlation between the log10 total plastic items/ha and the minimum distance to villages and cities in meter (m) from the sampled fields. B) Pearson's correlation between the log10 total plastic items/ha and the minimum distance to primary routes in meter (m) from the sampled fields. Dots represent the fields. Blue line represents the trend and the grey represents the SE. Significance level p = 0.05. n = 137.

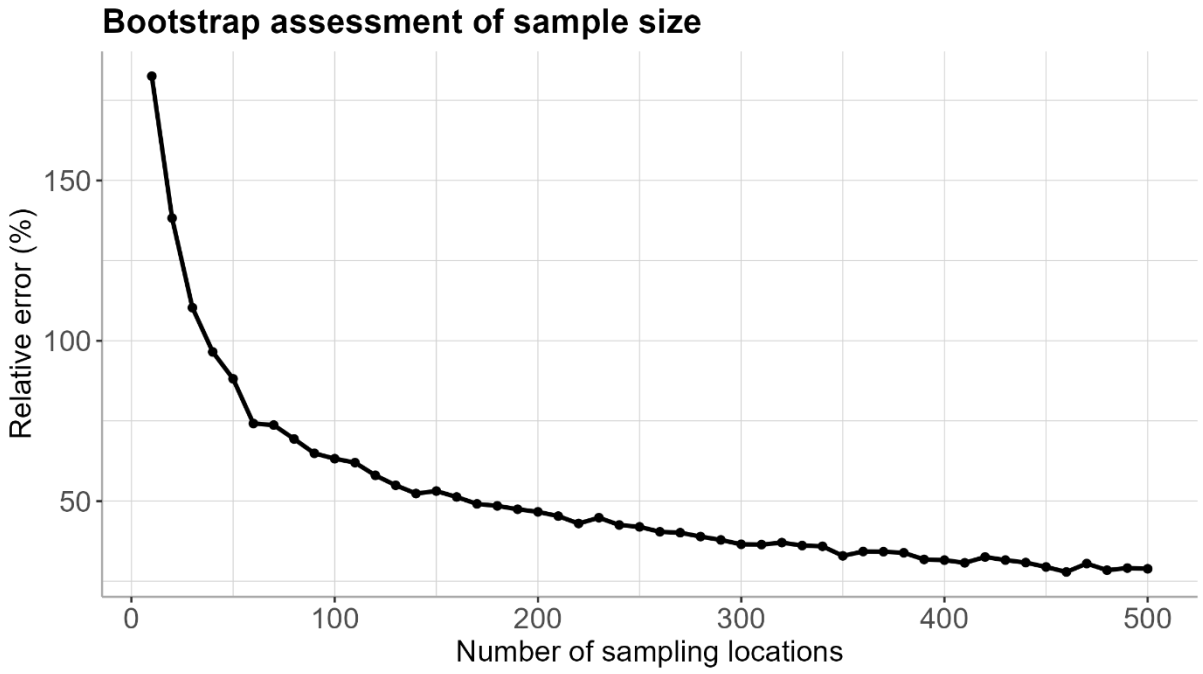

Figure S17: Bootstrap-based assessment of sampling effort required for terrestrial litter monitoring. The figure shows the relative error (%) between the observed mean macrolitter abundance across the 240 surveyed fields and the mean macrolitter abundance estimated through bootstrap resampling. For each sample size (n = 10–500 fields), 1,000 bootstrap samples were generated by random sampling with replacement from the complete dataset. The mean litter abundance was calculated for each iteration, and the relative error was derived from the 95% bootstrap confidence interval relative to the estimated mean. Lower relative error values indicate a more robust estimate of regional litter abundance.