Figure S1: <2 mm pine biochar (left) and >4 mm pine biochar (right).

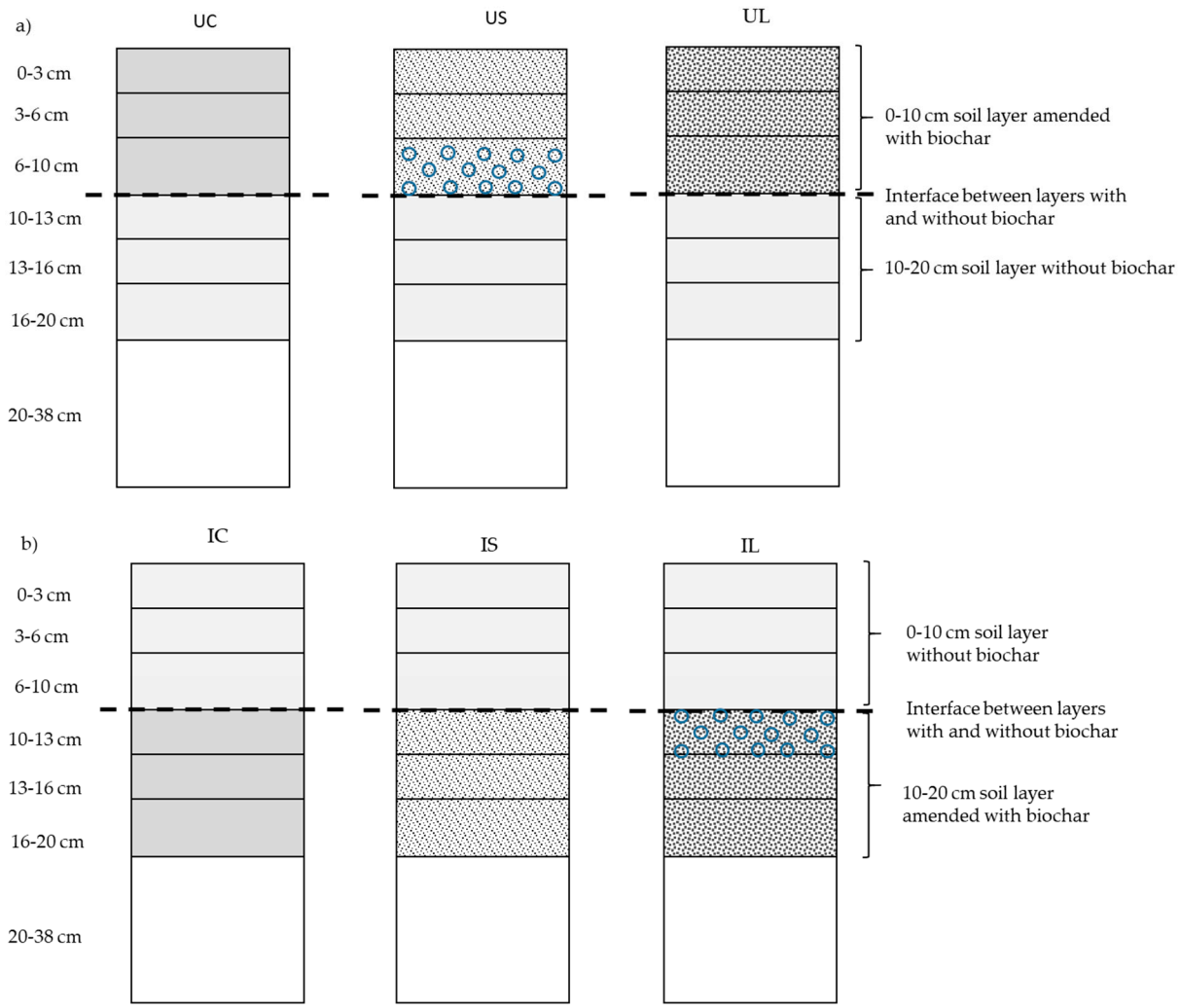

Figure S2: The soil in cores was packed as follows: a) Un-inverted soil; UC-control un-inverted; US – Un-inverted 0-10 cm with <2 mm biochar; UL – Un-inverted 0-10 cm with >4 mm biochar; b) Inverted soil; IC- Control inverted; IS- Inverted 0-10 cm with <2 mm biochar; IL - Inverted 0-10 cm with >4 mm biochar.

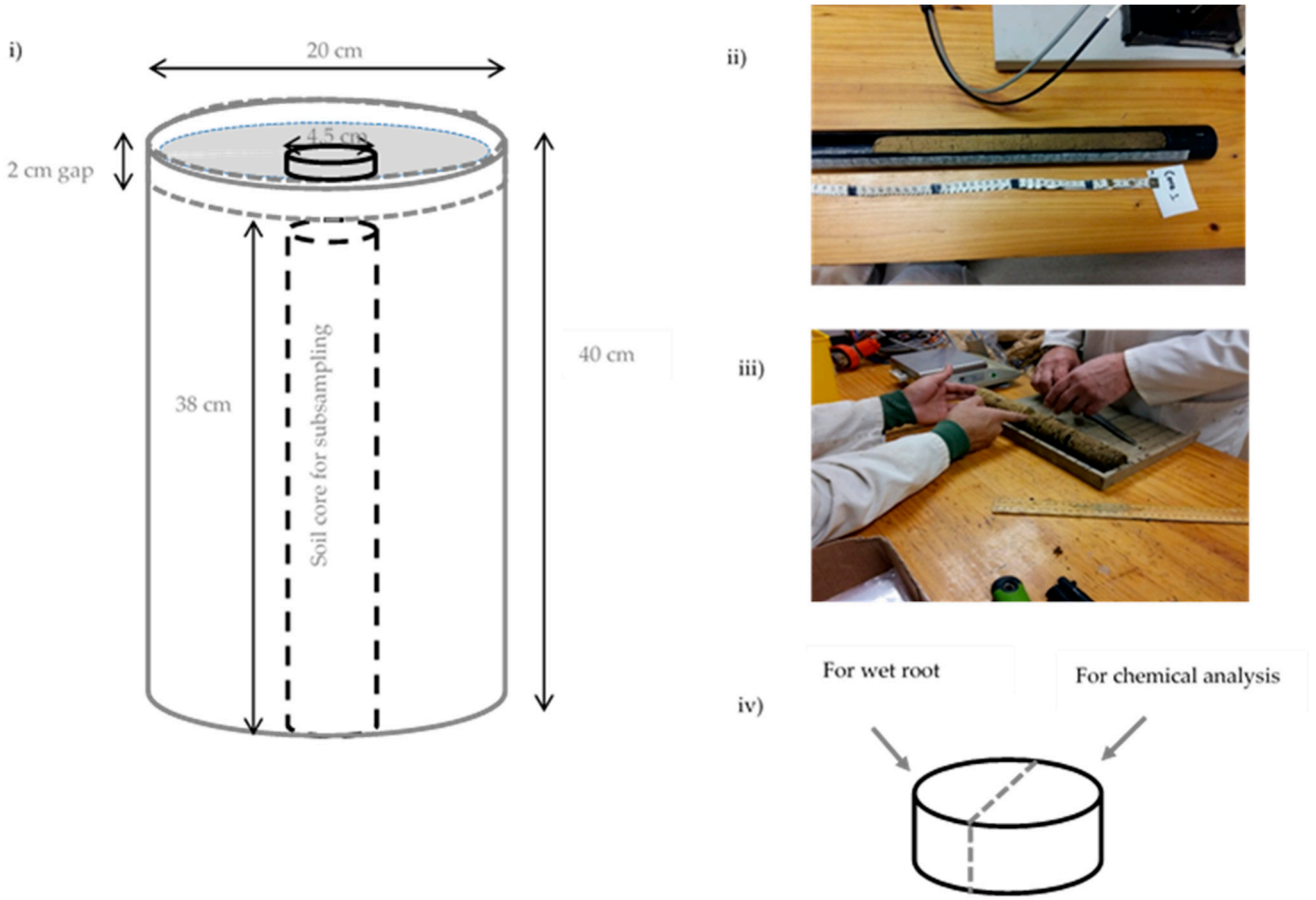

Figure S3: End-of-trial sampling; i) A soil core (subsample) was taken out from each core using a corer (diameter of 45 mm) from 0-38 cm depth; ii) Each core was scanned with NIRS; iii) soil was sliced according to designated depth; iv) each sliced soil was cut into half and separated for analysis.

Table S1: Time scale of the experiment.

Date	Week	Event
26/9/2014	1	Finish setting up all cores and first irrigation to reach 50% WFPS- topsoil (0-10 cm) has been mixed with basic fertilizer to stimulate seedlings (NPK; 60 kg N ha^{-1} ; 50 kg K ha^{-1} and 60 kg P ha^{-1}) N from urea, K from KCl and P from SSP.
10/10/2014	3	Sowing ryegrass seeds
4/11/2014	7	Thinning to 20 seedlings
13/11/2014	8	First harvest, cut to 5 cm length
24/11/2014	Week 10 & onward	Subsequent harvests
15/12/2014	13	Gas measurement to measure N_2O emission prior to urine application: sampling (day 0)- summer trial
16/12/2014	13	First application of cow urine equal to 354 kg N ha^{-1}, 3.5 mm of urine applied using syringe onto 1/3 of total area of soil core.
17/12/2014 until 3/2/2015	Weeks 13-20	Gas measurement day 1 to day 49
	Weeks 21-28	Gap
9 and 10/4/2015	29	Leaching before 2nd cow urine application
27/4/2015	32	Gas measurement to measure N_2O emission prior to urine application: sampling (day 0)-autumn trial
28/4/2015	32	Second application of cow urine equal to 563 kg N ha^{-1}
29-4-2015 until 16-6-2015	Weeks 32-39	Gas measurement day 1 to day 49
16-9-2015	52	Experiment setup dismantled. Soil cores were kept in the chiller room for further analysis.

Table S2. Soil pH of each layer measured at the end of the experiment.

Soil depth (cm)	Treatments							
	Un-inverted soil				Inverted soil			
	UC	US	UL	*p*-value	IC	IS	IL	*p*-value
Layer A (0-3 cm)	5.74a	5.72a	5.68a	0.906	5.68a	5.67a	5.62a	0.411
Layer B (3-6 cm)	5.65a	5.34a	5.43a	0.068	5.43a	5.39a	5.38a	0.875
Layer C (6-10 cm)	5.52a	5.43a	5.34a	0.481	5.29a	5.38a	5.37a	0.728
Layer D (10-13 cm)	5.59a	5.30a	5.34a	0.105	5.30a	5.42a	5.38a	0.745
Layer E (13-16 cm)	5.54a	5.25b	5.34b	0.034	5.29a	5.42a	5.37a	0.387
Layer F (16-20 cm)	5.53a	5.25a	5.38a	0.203	5.40a	5.43a	5.36a	0.647

UC-control un-inverted; US – Un-inverted 0-10 cm with <2 mm biochar; UL – Un-inverted 0-10 cm with >4 mm biochar; IC- Control inverted; IS- Inverted 0-10 cm with <2 mm biochar; IL - Inverted 0-10 cm with >4 mm biochar. Different letters denote significant differences at $p < 0.10$ between treatments ($n = 4$) for each layer. In the un-inverted soil biochar was at 0-10 cm depth; in the inverted soil biochar was at 10-20 cm depth.

Table S3. N_2O emission fluxes measured during summer and autumn trial (data showed for selected days only).

Summer Trial				
		Treatments		
Day	**Soil Inversion**	**Control**	**Small-particle size biochar**	**Large-particle size biochar**
Day prior to urine application	Un-inverted	0.12bB	1.51aA	0.50bA
	Inverted	**2.08**aA	1.63aA	0.19aA
Day after urine application with maximum N_2O peak	Un-inverted	30.5aA	60.7aA	54.2aA
	Inverted	13.9aA	25.4aA	29.1aA
Day 10 after urine application	Un-inverted	3.11aA	3.18aA	4.41aA
	Inverted	2.70aA	15.9aA	7.90aA
Autumn Trial				
		Treatments		
Day	**Soil Inversion**	**Control**	**Small-particle size biochar**	**Large-particle size biochar**
Day prior to urine application	Un-inverted	0.76bB	4.61aA	3.24aB
	Inverted	**21.8**aA	4.36bA	**24.8**aA
Day after urine application with maximum N_2O peak	Un-inverted	40.9aA	85.7aA	69.7aA
	Inverted	66.9aA	59.7aA	93.8aA
Day 10 after urine application	Un-inverted	14.6aA	28.6aA	14.1aA
	Inverted	9.43aA	23.4aA	22.7aA

Within a specific season, (i) different small letters within a row indicate differences between biochar treatments ($n = 4$) and $p < 0.10$), and (ii) different uppercase letters within a column indicate differences between un-inverted and inverted treatments ($n = 4$ and $p < 0.10$).

Table S2: Treatment effects on the amount of NO_3-N measured for every leaching event.

Leaching event	NO_3-N leachate (NO_3^-N g m^{-2} / % of added N leached as NO_3^-N)							
	UC	US	UL	*p*-value	IC	IS	IL	*p*-value
1st	0.073/0.21a	0.036/0.10a	0.066/0.19a	0.680	0.030/0.08a	0.035/0.10a	0.036/0.10a	0.933
2nd	0.015/0.04a	0.026/0.07a	0.018/0.05a	0.683	0.013/0.04a	0.060/0.17a	0.021/0.06a	0.132
3rd	0.015/0.03a	0.022/0.04a	0.015/0.03a	0.634	0.020/0.03a	0.025/0.04a	0.036/0.06a	0.426

UC - control un-inverted; US – Un-inverted 0-10 cm with <2 mm biochar; UL – un-inverted 0-10 cm with >4 mm biochar; IC - control inverted; IS - inverted 0-10 cm with <2 mm biochar; IL - inverted 0-10 cm with >4 mm biochar. Different letters denote significant differences at $p < 0.10$ between treatments at each leaching event ($n = 4$).

Table S3: Soil bulk density (g/cm^{-3}) at each depth measured at the end of the experiment.

Soil depth (cm)	Treatments							
	Un-inverted soil				Inverted soil			
	UC	US	UL	*p*-value	IC	IS	IL	*p*-value
Layer A (0-3 cm)	0.92a	0.93a	0.84a	0.115	1.16a	1.06a	1.12a	0.271
Layer B (3-6 cm)	1.04a	0.99a	0.94a	0.106	1.14a	1.19a	1.18a	0.792
Layer C (6-10 cm)	0.97a	1.06a	0.99a	0.101	1.05a	1.17a	1.08a	0.186
Layer D (10-13 cm)	1.18a	1.18a	1.12a	0.741	0.92a	0.95a	1.00a	0.327
Layer E (13-16 cm)	1.17a	1.10a	1.11a	0.599	1.00a	0.94a	0.92a	0.417
Layer F (16-20 cm)	1.18a	1.10a	1.08a	0.183	1.00a	0.91a	0.93a	0.267

UC - control un-inverted; US – Un-inverted 0-10 cm with <2 mm biochar; UL – un-inverted 0-10 cm with >4 mm biochar; IC - control inverted; IS - inverted 0-10 cm with <2 mm biochar; IL - inverted 0-10 cm with >4 mm biochar. Different letters denote significant differences at $p < 0.10$ between treatments ($n = 4$) for each layer. In the un-inverted soil biochar was at 0-10 cm depth; in the inverted soil biochar was at 10-20 cm depth.

Table S4: Volumetric soil moisture contents (%) at different matric potentials including the available water content (AWC) measured after the end of the experiment.

Matric potential	Soil depth (cm)	Treatments							
		Un-inverted soil				Inverted soil			
		UC	US	UL	*p*-value	IC	IS	IL	*p*-value
-15bar	0-3	14.79±0.60	14.35±0.94	14.12±0.91	ns	14.79±0.85	14.02±0.12	14.61±0.86	ns
	3-6	19.78±0.67	19.36±0.78	18.58±0.77	ns	17.25±0.15	20.34±2.16	19.27±2.61	ns
	6-10	17.45b±0.01	19.37a±0.62	19.11a±0.03	**0.058**	18.51±6.70	18.25±0.60	17.25±2.09	ns
	10-13	18.85±1.06	19.98±0.10	16.46±1.91	ns	14.73b±0.90	16.22b±0.50	19.68a±0.35	**0.024**
	13-16	20.45±0.45	21.38±0.15	19.32±3.11	ns	20.28±0.21	16.21±0.82	18.52±1.08	ns
	16-20	20.79±0.62	20.81±0.12	19.49±1.75	ns	20.73±0.75	17.32±0.91	18.64±1.94	ns
-1bar	0-3	21.62±0.85	21.40±1.82	19.82±1.28	ns	19.98±1.34	19.22±0.17	19.96±0.98	ns
	3-6	26.17±0.27	24.89±2.21	23.45±1.02	ns	22.72±2.07	24.67±2.50	23.15±2.81	ns
	6-10	22.81b±0.14	27.81a±0.88	24.01b±0.37	**0.016**	15.43±1.02	22.15±1.01	20.74±2.52	ns
	10-13	26.16±1.93	26.96±0.88	22.37±2.60	ns	20.43b±0.95	21.66b±0.81	24.77a±0.28	**0.053**
	13-16	24.20±0.22	25.72±0.12	22.79±3.63	ns	24.00±1.04	20.99±1.53	22.86±1.18	ns
	16-20	24.05±1.46	21.13±2.53	21.92±2.31	ns	24.71±0.61	20.76±0.92	23.13±1.70	ns
-0.3 bar	0-3	27.31±1.08	26.99±2.18	24.58±1.67	ns	26.36±1.99	24.92±0.01	26.15±1.01	ns
	3-6	34.22±0.49	32.06±1.72	30.68±0.01	ns	27.66±0.25	32.72±2.87	30.71±3.15	ns
	6-10	28.76b±0.41	34.04a±1.24	30.06b±0.02	**0.032**	19.57±1.43	28.07±1.01	26.49±3.00	ns
	10-13	32.16±5.09	29.68±1.03	25.44±3.24	ns	23.52b±1.25	25.24b±0.72	28.99a±1.13	**0.074**
	13-16	29.07±0.27	29.23±0.08	26.85±4.42	ns	29.45±0.40	25.15±1.99	26.74±1.42	ns
	16-20	30.51±0.98	28.32±0.51	27.51±2.83	ns	28.89±0.50	26.61±1.01	27.57±2.37	ns
AWC	0-3	12.52±0.48	12.64±1.24	10.46±0.76	ns	11.58±1.14	10.90±0.12	11.55±0.16	ns
	3-6	14.45±0.19	12.69±0.94	12.10±0.76	ns	10.42±0.10	12.39±0.72	11.44±0.54	ns
	6-10	11.31±0.40	14.68±1.86	10.94±0.05	ns	4.38±1.94	9.82±0.41	9.24±0.91	ns
	10-13	13.31±4.04	9.70±0.93	8.98±1.32	ns	8.79±0.35	9.02±0.22	9.31±0.78	ns
	13-16	8.63±0.19	7.85±0.23	7.53±1.32	ns	9.17±0.20	8.94±1.17	8.21±0.35	ns
	16-20	9.73±0.36	7.51±0.39	8.02±1.08	ns	8.17±0.25	9.30±0.10	8.93±0.44	ns

UC-control un-inverted; US – Un-inverted 0-10 cm with <2 mm biochar; UL – Un-inverted 0-10 cm with >4 mm biochar; IC- Control inverted; IS- Inverted 0-10 cm with <2mm biochar; IL - Inverted 0-10 cm with >4 mm biochar. SEM (n = 4) and significant differences were detected at $p < 0.10$. Different letters denote significant differences between treatments for each layer. In the un-inverted soil biochar was at 0-10 cm depth; in the inverted soil biochar was at 10-20 cm depth.

Table S5: Soil total C (%) of each layer measured at the end of the experiment.

Soil depth (cm)	Treatments							
	Un-inverted soil				Inverted soil			
	UC	US	UL	*p*-value	IC	IS	IL	*p*-value
Layer A (0-3 cm)	3.85 b	5.64 a	5.23 a	**0.000**	2.49a	2.47a	2.33a	0.187
Layer B (3-6 cm)	3.76 b	5.18 a	4.91 a	**0.000**	2.27a	2.34a	2.35a	0.176
Layer C (6-10 cm)	3.23 b	4.93 a	4.77 a	**0.001**	2.32a	2.30a	2.32a	0.900
Layer D (10-13 cm)	2.30a	2.30a	2.31a	0.971	3.42 b	5.04 a	4.79 a	**0.003**
Layer E (13-16 cm)	2.24a	2.29a	2.29a	0.299	3.61 c	5.20 a	4.58 b	**0.000**
Layer F (16-20 cm)	1.96a	2.17a	2.30a	0.100	3.24 c	5.22 a	4.09 b	**0.000**

UC - control un-inverted; US – Un-inverted 0-10 cm with <2 mm biochar; UL – un-inverted 0-10 cm with >4 mm biochar; IC - control inverted; IS - inverted 0-10 cm with <2 mm biochar; IL - inverted 0-10 cm with >4 mm biochar. Different letters denote significant differences at $p < 0.10$ between treatments (n = 4) for each layer. In the un-inverted soil, biochar was at 0-10 cm depth; in the inverted soil biochar was at 10-20 cm depth.

Table S6: Dry root (mg cm^{-3}) in each soil layer measured at the end of the experiment.

Soil depth (cm)	Treatments							
	Un-inverted soil				Inverted soil			
	UC	US	UL	*p*-value	IC	IS	IL	*p*-value
Layer A (0-3 cm)	5.61a	10.99a	5.61a	0.522	5.83a	9.87a	7.63a	0.415
Layer B (3-6 cm)	4.04a	1.35a	3.59a	0.318	1.57a	0.90a	1.79a	0.539
Layer C (6-10 cm)	0.68a	0.85a	0.85a	0.908	0.34 a	1.88 b	1.54 b	**0.078**
Layer D (10-13 cm)	0.45a	0.67a	0.90a	0.192	2.69 a	1.12 b	0.67 b	**0.009**
Layer E (13-16 cm)	0.45a	0.43a	0.44a	1.000	0.67a	0.90a	0.89a	0.898
Layer F (16-20 cm)	0.34a	0.33a	0.51a	0.829	0.34a	0.51a	0.85a	0.563

UC - control un-inverted; US – Un-inverted 0-10 cm with <2 mm biochar; UL – un-inverted 0-10 cm with >4 mm biochar; IC - control inverted; IS - inverted 0-10 cm with <2 mm biochar; IL - inverted 0-10 cm with >4 mm biochar. Different letters denote significant differences at $p < 0.10$ between treatments ($n = 4$) for each layer. In the un-inverted soil, biochar was at 0-10 cm depth; in the inverted soil biochar was at 10-20 cm depth.