

Figure 1. Map showing location of sampling locations in Senegal and Tongo Maaré Diabal, Mali. Weather stations with rainfall data for 2016 and 2017 are marked as triangles. Annual rainfall data are derived from interpolation of average monthly climate data for 1970–2000, available from the WorldClim database, version 2 (Fick and Hijmans, 2017).

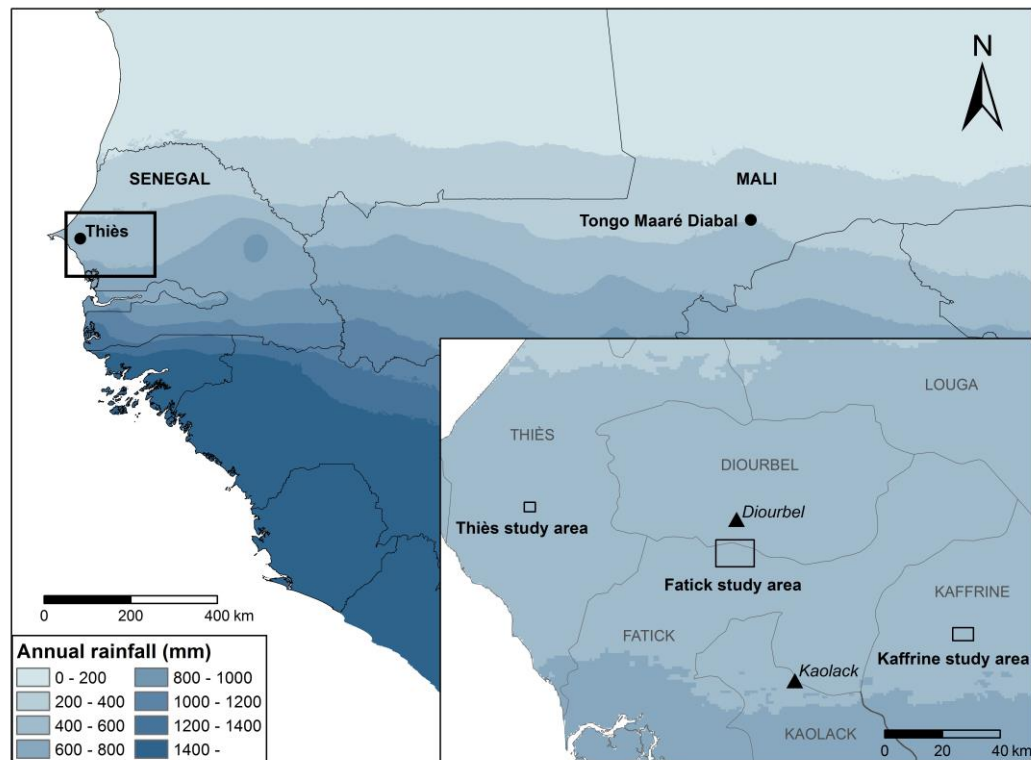


Figure 2. Pearl millet plot NJI01 in the Fatick study area in northeast Senegal. Pearl millet plants are c. 2 m high. Photograph taken by A. Styring.



Figure 3. Excavation Unit G at Tongo Maaré Diabal in February 2010, with Gandamia escarpment in the background. Photograph taken by N. Gestrich.



Figure 4. Comparison of $\delta^{15}\text{N}$ values of pearl millet grains sampled from different points along single panicles.

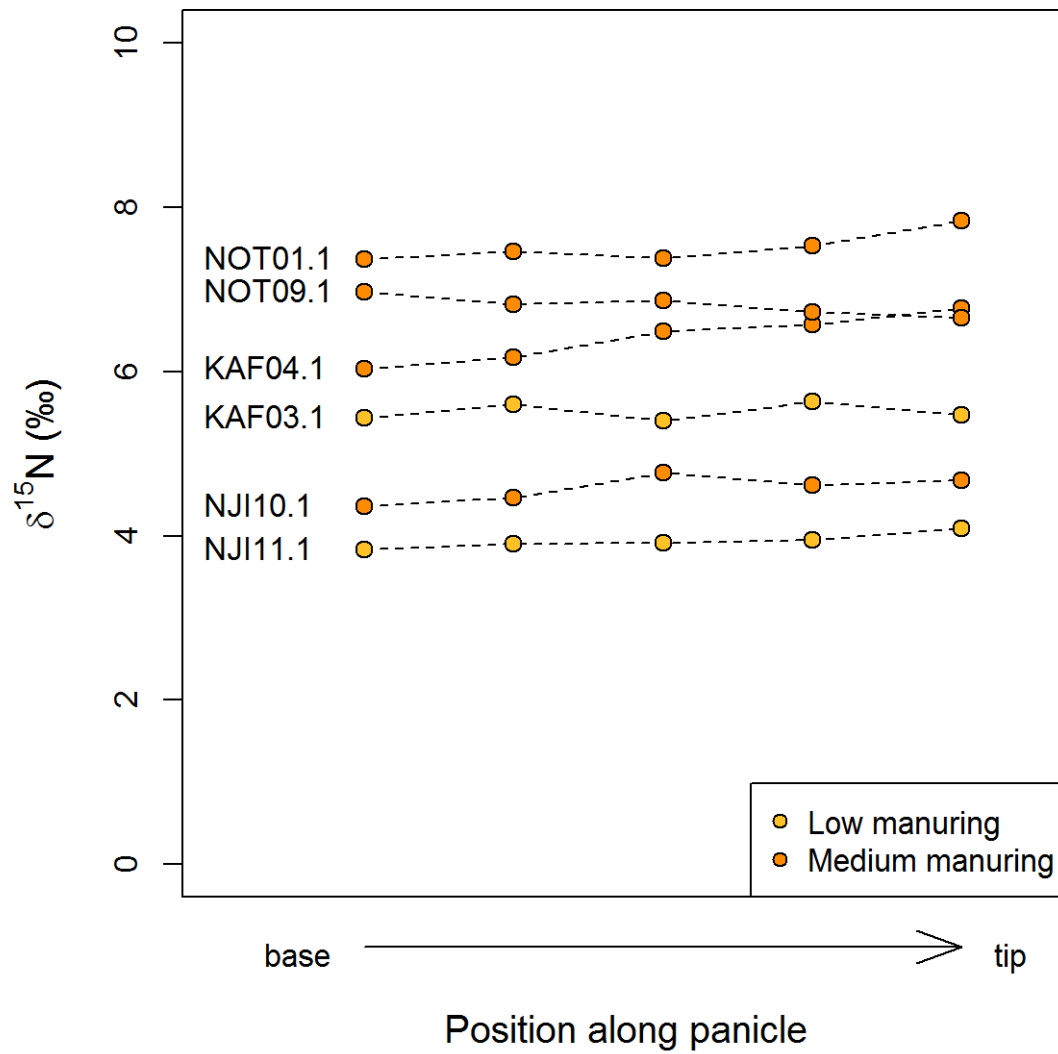


Figure 5. Comparison of $\delta^{15}\text{N}$ values of pearl millet grains sampled from different panicles from single plots. Vertical lines represent the mean $\pm$ 95% confidence interval for within plot $\delta^{15}\text{N}$ values. Stars represent the $\delta^{15}\text{N}$ value of 30 grains homogenised from ten panicles from each plot.

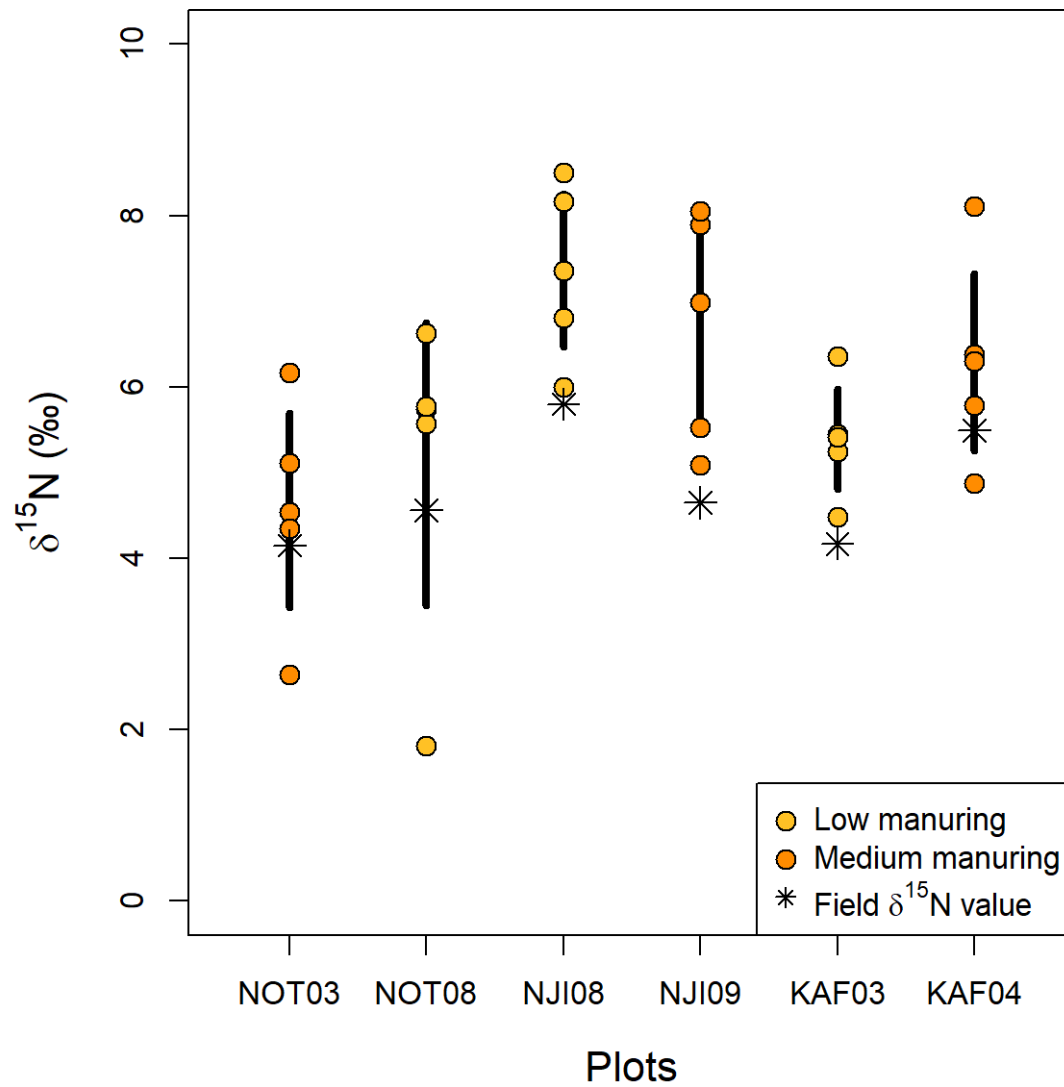


Figure 6. Comparison of $\delta^{15}\text{N}$ values of pearl millet grains from plots classified as receiving low and medium levels of manure/organic matter. Low level manuring means plots have received no manure/household waste for >2 years. Medium level manuring means plots received manure/household waste in the year prior to harvest. Boxes represent the quartiles, the bold line represents the median and whiskers represent 1.5x the interquartile range.

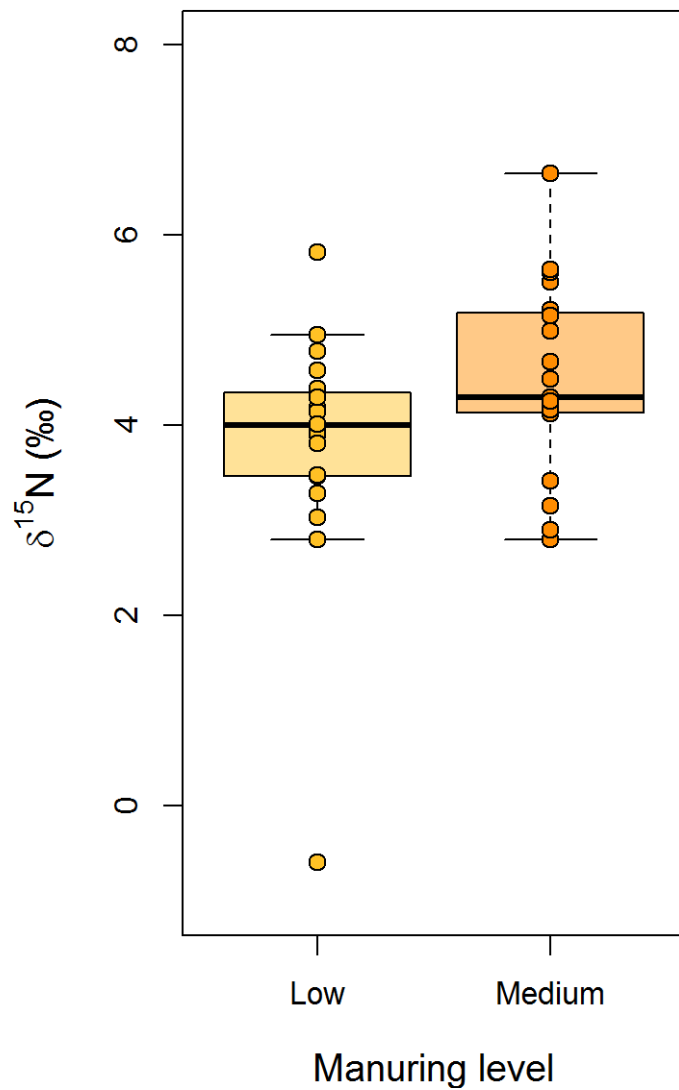


Figure 7. a) Modern cereal grain $\delta^{15}\text{N}$ values plotted against the natural log of mean annual rainfall, colour coded by manuring level. The solid lines represent a fitted linear model relating cereal grain $\delta^{15}\text{N}$ values to mean annual rainfall for each manuring level. The dotted lines represent the thresholds between manuring levels. Squares outlined in black represent pearl millet grains sampled in northeast Senegal. Circles outlined in black represent cereal grains sampled from small-scale traditional farms (locations are given adjacent to these data points). **b)** As for Figure 5a), but pearl millet grains sampled from northeast Senegal (squares outlined in black) are colour coded by the manuring level that is *imputed* using the fitted linear model. All crop $\delta^{15}\text{N}$ values, apart from those of pearl millet from Senegal, have been previously published in Styring et al. (2017a).

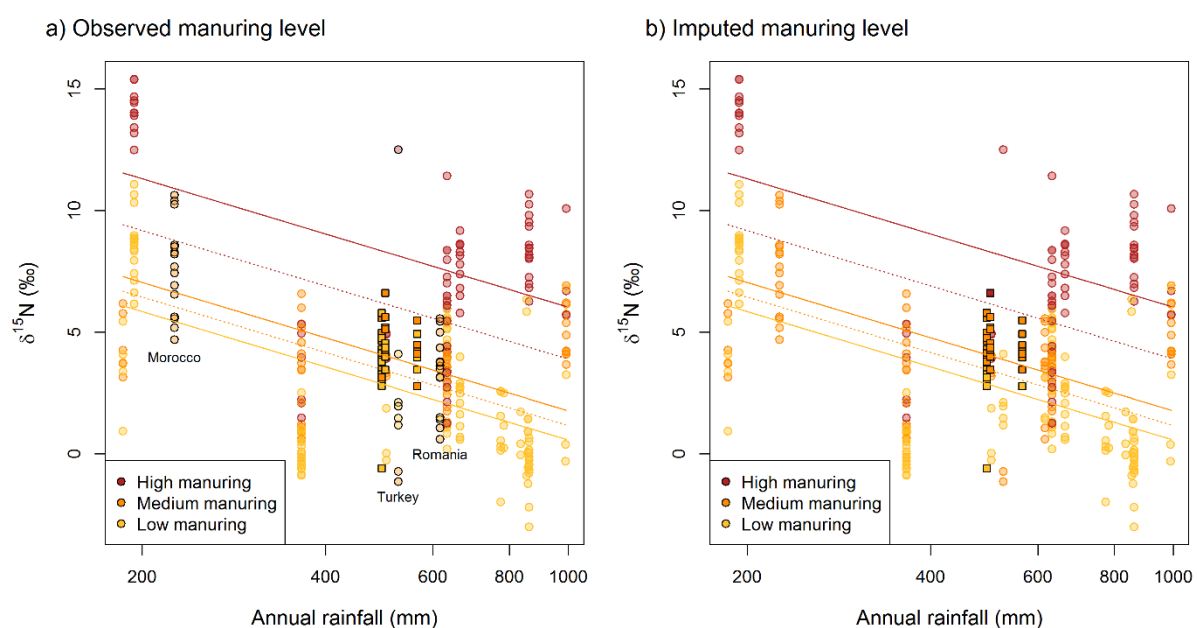


Figure 8. Summary of % mass loss for seven different crop taxa charred at 215–260°C for 4–24 h. The data for all taxa apart from pearl millet have been previously published in Nitsch et al. (2015).

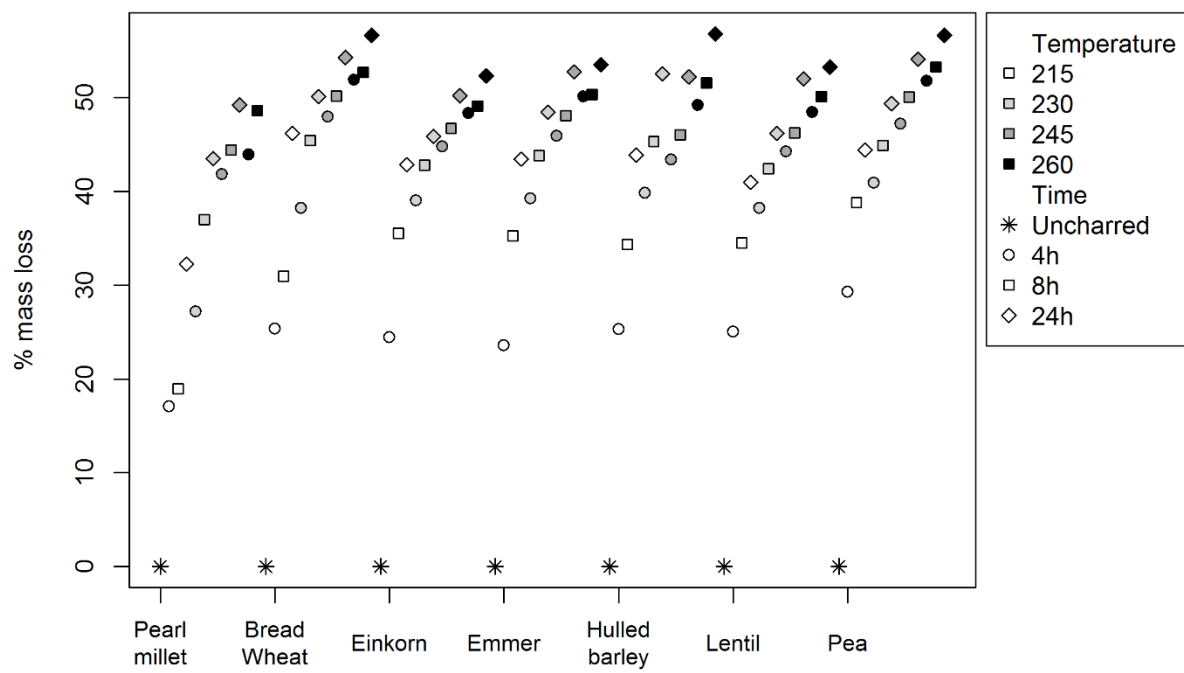


Figure 9. Changes in **a) %C**, **b) %N** and **c) C/N molar ratio** due to charring for seven different crop taxa charred at 215–260°C for 4–24 h. The data for all taxa apart from pearl millet have been previously published in Nitsch et al. (2015).

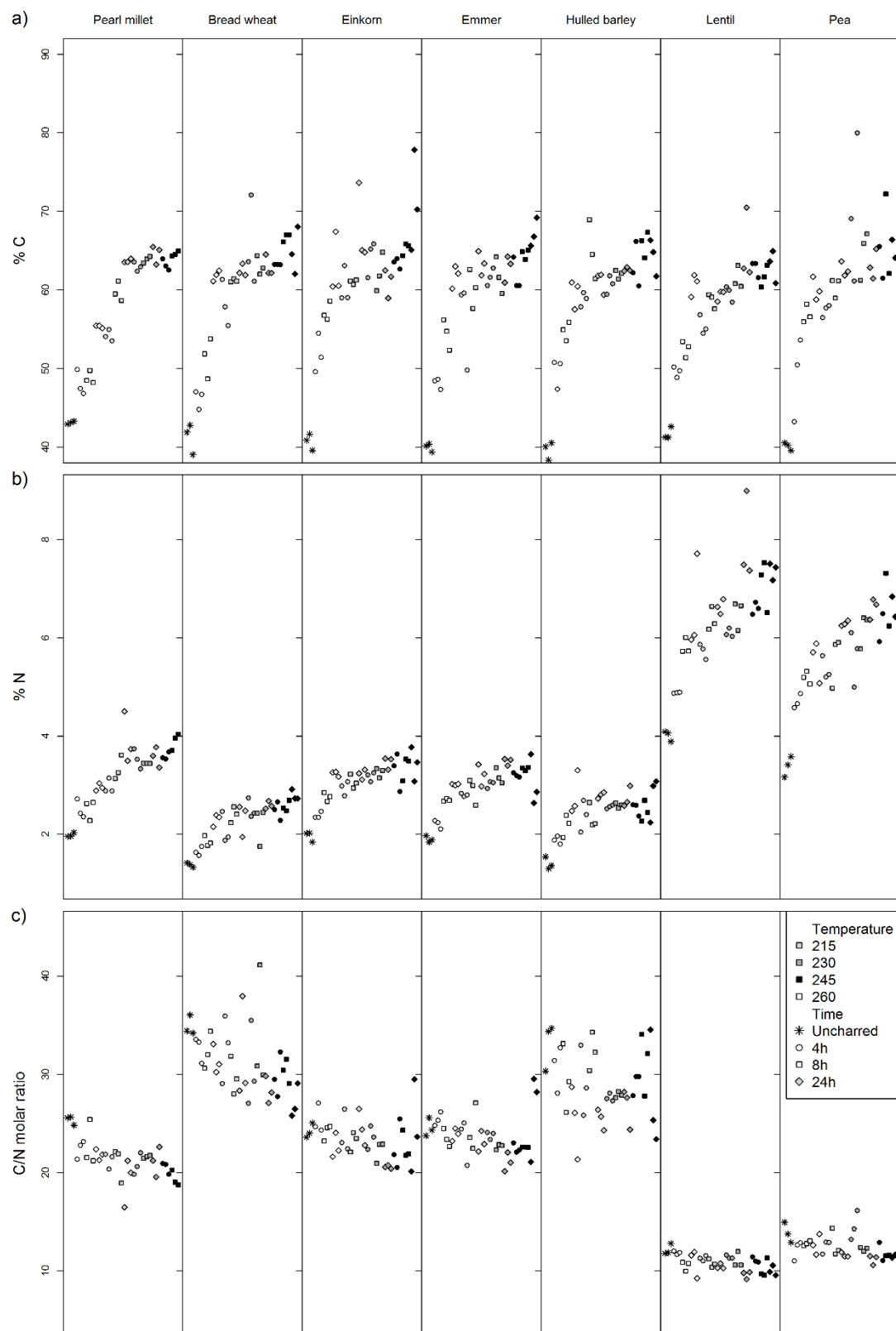


Figure 10. $\delta^{15}\text{N}$ values of seven crop taxa charred at 215–260°C for 4–24 h compared to the mean $\delta^{15}\text{N}$ value of three uncharred replicates. The data for all taxa apart from pearl millet have been previously published in Nitsch et al. (2015).

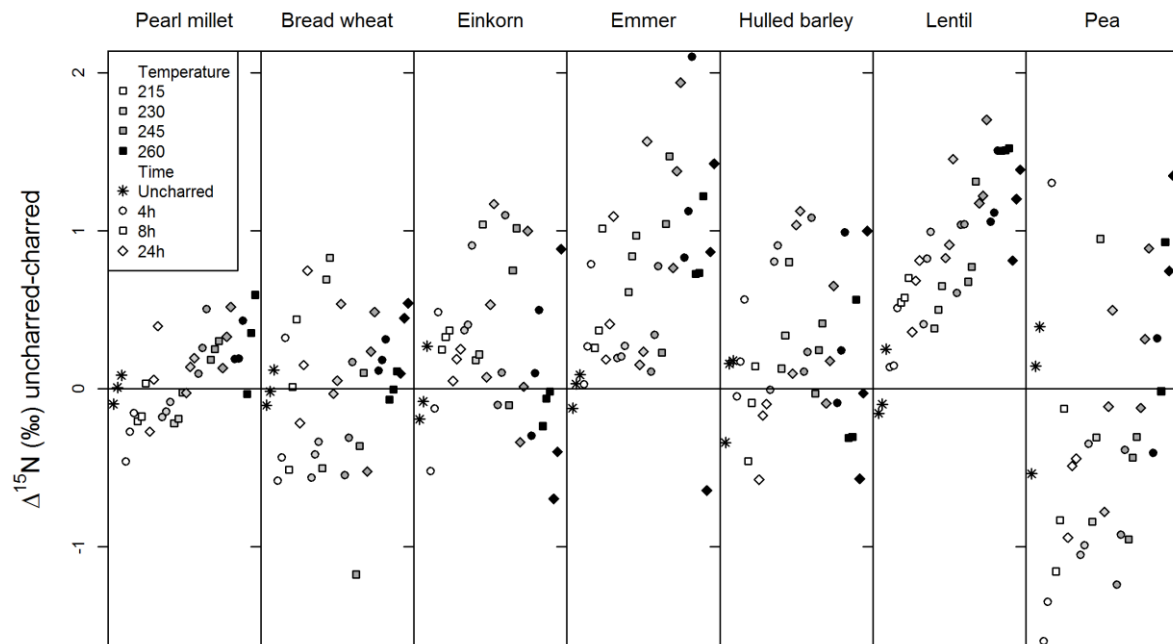


Figure 11. $\delta^{15}\text{N}$ values of pearl millet grain samples from Tongo Maaré Diabal, Mali, plotted against date. The crop samples are grouped by archaeological horizon and plotted against the midpoint of the date range for each horizon, apart from Horizon 3 where an upper and lower portion were distinguished in the archaeology. The horizons are dated based on stratigraphic relationships to radiocarbon-dated contexts. The points are colour-coded by their manuring level, which is imputed from the $\delta^{15}\text{N}$ values and the present-day rainfall at the site using a fitted linear model.

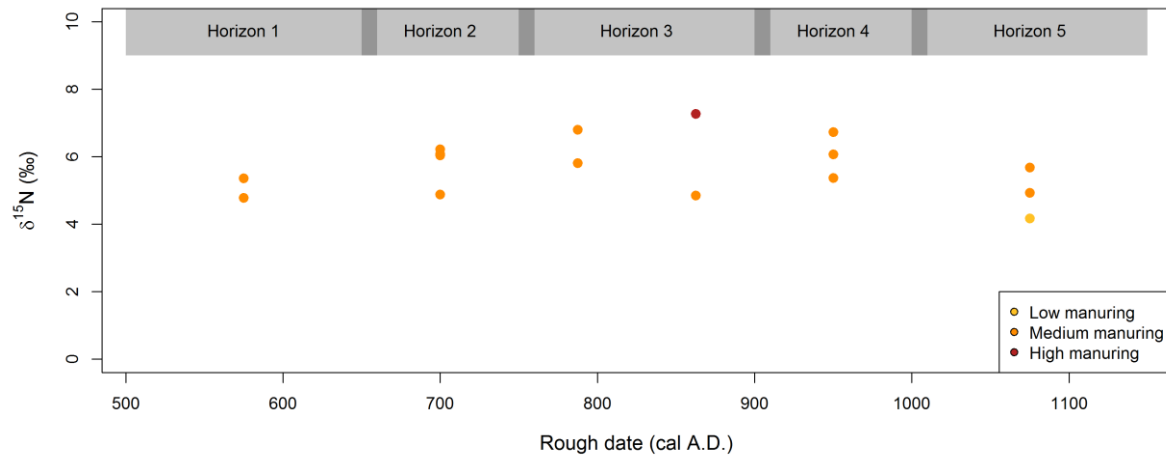


Table 1. Summary of the study regions in northeast Senegal

Département	Thiès	Fatick	Kaffrine
Abbreviation	NOT	NJI	KAF
Approximate location	14.7 N, -16.9 E	14.6 N, -16.2 E	14.3 N, -15.5 E
Interpolated annual rainfall (mm)	501	494	565
No. plots	11	18	9
Average plot area (ha)	1.2	0.6	2.2
Average crop height (cm)	236	263	233
Soils	Leptosols and regosols	Arenosols	Lixisols
Average soil organic matter content (%)	0.5	0.5	0.5
Average potential cation exchange capacity (mmol/100 g at pH 8.2)	33	31	22
Average soil pH (KCl)	5.6	6.7	5.9
Rotation regime	Mostly peanut-millet-peanut	Mostly peanut-millet-peanut; some millet only; one plot cowpea-millet	Mostly peanut-millet-peanut; two fallow before millet
Sowing time	July 2017	July 2017	June/July 2017
Tillage and harrowing	Horse-drawn plough in March/April 2017	Horse-drawn plough in July 2017	Horse-drawn plough in June/July 2017
Weeding		With a hoe	
Manuring	7 with manure/compost; 4 without	7 with manure/compost; 11 without	4 with manure/compost; 5 without
Harvest time		October 2017	

Table 2. Summary of the chronology of the archaeological horizons excavated at Tongo Maaré Diabal, Mali (after Gestrich and MacDonald 2018).

	Date
Horizon 5	cal A.D. 1000–1150
Horizon 4	cal A.D. 900–1000
Horizon 3 upper and lower	cal A.D. 750–900
Horizon 2	cal A.D. 650–750
Horizon 1	cal A.D. 500–650

Table 3. A confusion matrix for prediction of manuring level of pearl millet grains sampled in Senegal. Numbers are percentages. Figures in bold designate correct predictions. Rows sum to 100.

		<i>Predicted</i>		
<i>True</i>		Low	Medium	High
	Low	26	74	0
	Medium	21	74	5
	High	NA	NA	NA