Supplementary Material

Soil sampling sites

Pasture soils with varying physical and chemical characteristics were collected from 10 New Zealand dairy farms (Fig. 1). All the sites from which the soil samples were collected are commercially managed farms (Table 1) containing mixed pasture, perennial ryegrass (*Lolium perenne)*, and white clover (*Trifolium repens*). Fertilization regimes varied among the sites and consisted of applications of 150–200 kg N ha^{-1}. TeK, HR, PL, and MF soils received 150 kg N ha^{-1} annually; OH and MWEI received 160 kg N ha^{-1} annually, while PS, LM and MW received 200 kg N ha^{-1}.

The soils were selected on the basis of their geographical location (North or South Island of New Zealand), variation in mineralogy, whether they were non-allophanic (MW, MWEI, PS, PL, TM, LM, TeK) or allophanic soils (HR, OH). These sites represented soil varying in physical characteristics from poorly drained (TM, TeK) to well drained (OH, HR, MW, MWEI). Soil texture varied from stony silt loam (LM) to fine sandy loam (MW). The two Manawatu soils were collected from two adjoining paddocks; one had no irrigation, the other had received effluent (liquid farm waste flowing out of the farms, mainly composed of animal waste, milk, feed, and water) irrigation at the rate of 10 000 L ha^{-1} every 2 months, for the past 16 years. The effluent was applied 2 weeks before the collection of soil samples. Two Paparua soils were collected from dairy farms in Springston and Lincoln. These two sites differed in the amounts of annual N applied on the farms in split applications of 50 kg N ha^{-1} 3–4 times in a year (Lincoln 150 kg N $ha^{-1}yr^{-1}$ and Springston 200 kg N ha^{-1} yr^{-1}).

Table S1: One way ANOVA *P*–values of the chemical characteristics in different soils (S) used in this study collected from two sampling depths (0 -100 mm & 100 - 200 mm)(D)

Variables	**Source- Soil Type** **(P values)**
Total-C	0.0001
Total-N	0.0001
pH	0.0001
Olsen P	0.0001
MBC	0.0001
Soluble C	0.0001
NO_3^-–N	0.0001
NH_4^+–N	0.0001
SWC	0.0001

Table S2: Chemical characteristics measured in soils collected from 0 -100 and 100 - 200 mm depth from 10 dairy–pasture farms in New Zealand. Data are mean (n=6) ± Standard error of mean (S.E.M.)

Group	Total C (g kg^{-1} soil)	Total N (g kg^{-1} soil)	pH (1:2.5, soil: water)	Olsen P (mg kg^{-1} soil)	MBC (mg kg^{-1} soil)	Soluble C (mg kg^{-1} soil)	Nitrate-N (mg kg^{-1} soil)	Ammo-N (mg kg^{-1} soil)	Gravimetric SWC (%)	DEA
1	72.7 ± 3.1^{A}	7.4 ± 0.3^{A}	5.7 ± 0.0^{A}	23.3 ± 0.4^{C}	503 ± 29^{B}	227 ± 11^{A}	11.6 ± 0.9^{B}	12.2 ± 0.5^{A}	52.8 ± 1.0^{A}	549 ± 131^{C}
2	50.9 ± 2.0^{B}	5.2 ± 0.3^{B}	5.9 ± 0.0^{A}	60.7 ± 6.0^{A}	970 ± 74^{A}	53 ± 13^{B}	58.8 ± 3.5^{A}	0.9 ± 0.1^{C}	36.1 ± 1.4^{B}	2533 ± 379^{A}
3	37.9 ± 1.0^{C}	3.5 ± 0.1^{C}	5.8 ± 0.1^{A}	43.9 ± 2.5^{B}	615 ± 24^{B}	104 ± 8^{C}	18.0 ± 1.9^{B}	7.9 ± 0.7^{B}	39.1 ± 3.4^{B}	1298 ± 185^{B}

Letters denote one way ANOVA test. Values sharing same letter are not significantly different. MWEI = Manawatu fine sandy loam (effluent irrigated); MW = Manawatu fine sandy loam; TM = Tokomaru silt loam; TeK = Te Kowhai silt loam; OH = Otorohonga silt loam; HR = Horotiu silt loam; PS = Paparua silt loam (Springston); LM = Lismore stony silt loam; MF = Mayfield silt loam; PL = Paparua silt loam (Lincoln). C = carbon, N = nitrogen, P= phosphorus, MBC = microbial biomass carbon, Ammo = ammonical, SWC = soil water content, DEA = Denitrification enzyme activity.

Table S3: Pearson's correlation coefficients ($P < 0.05$) between denitrification enzyme activity with soil factors (0 - 100 mm).

	Denitrification enzyme activity
pH	0.320
Olsen P	0.229
MBC	0.385
Soluble C	-0.239
NO_3–N	0.688
NH_4–N	-0.554
*nir*S+*nir*K gene copies	-0.455
*nos*Z gene copies	0.253