From Fertilizer to Food: Tracing N Dynamics in Organic and Conventional Cropping Systems Using ^{15}N

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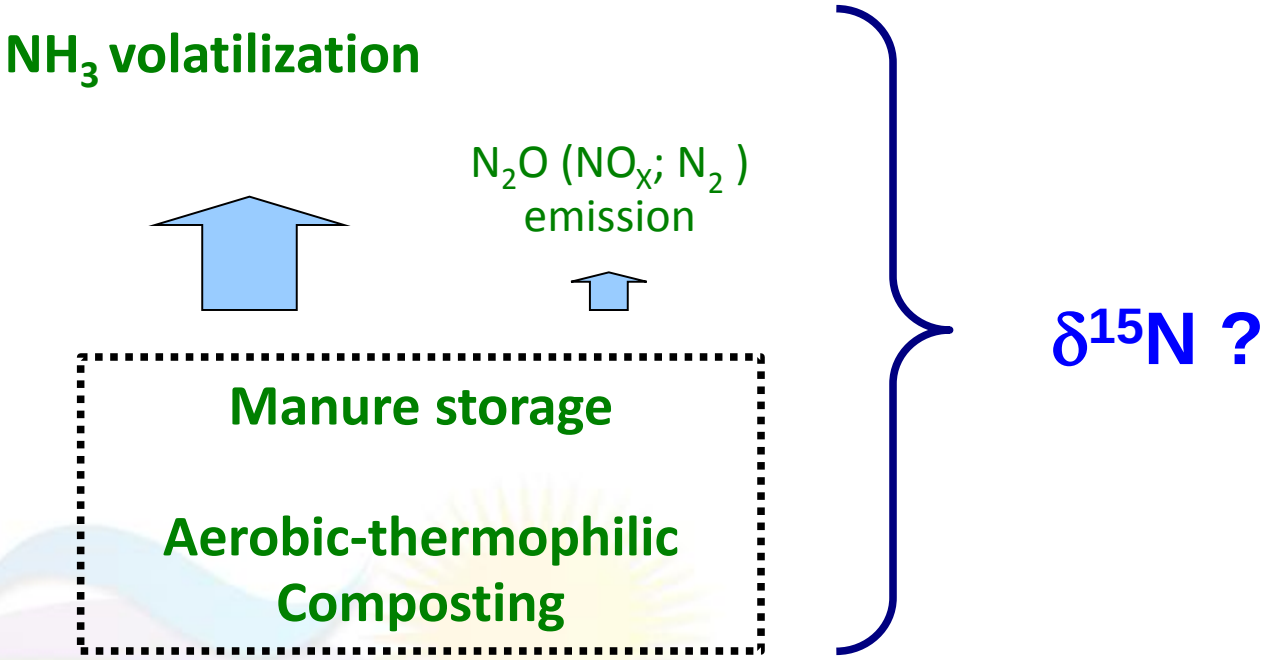
Gaseous N losses and $\delta^{15}N$ signatures during storage or composting of animal wastes



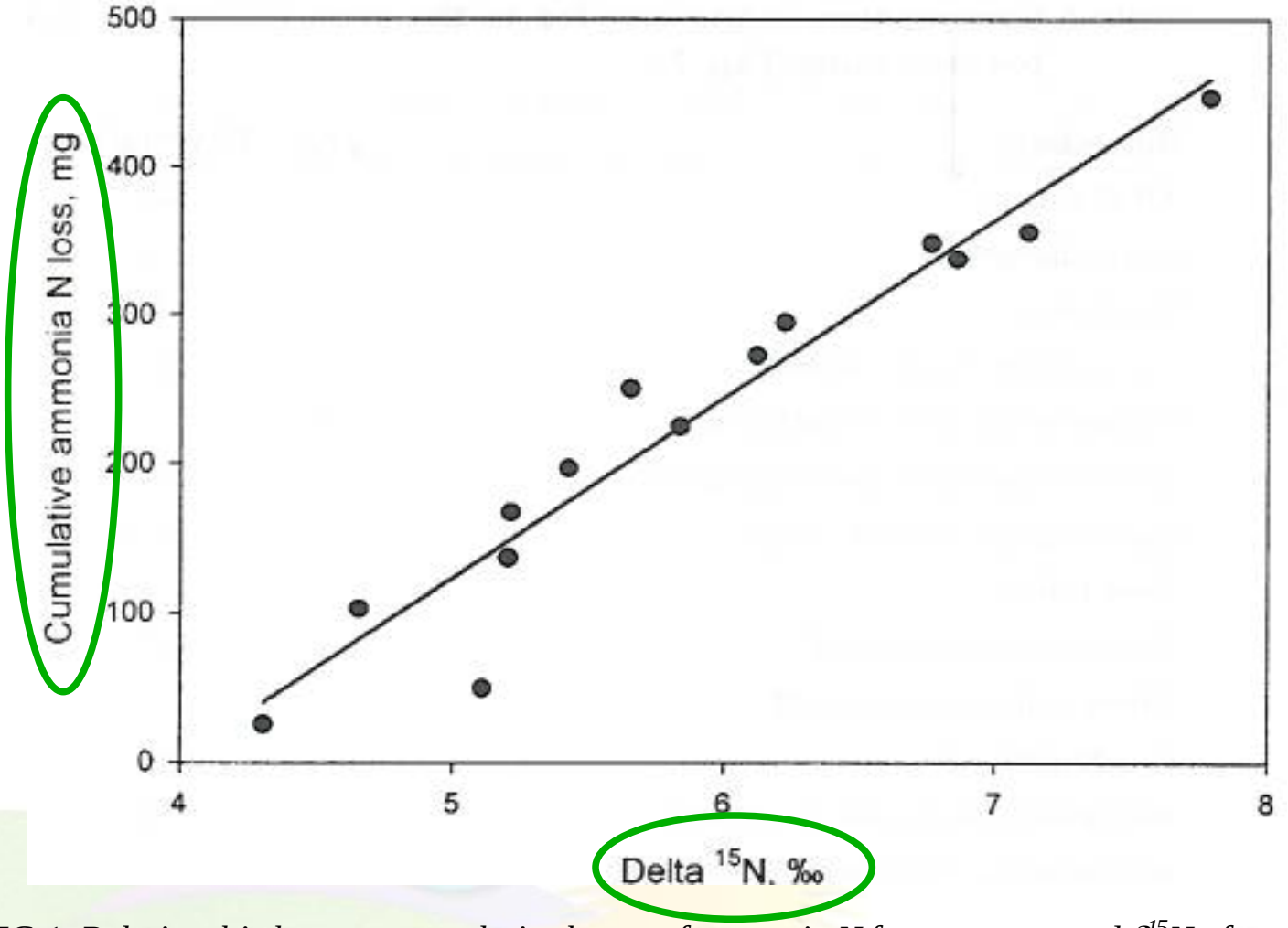


FIG.1. Relationship between cumulative losses of ammonia N from manure and $\delta^{15}N$ of manure

HRISTOV, A.N., et al., J. Environ. Qual. 38 (2009) 2438–2448

$\delta^{15}N$ signatures of synthetic vs. organic fertilizers

Organic fertilizers → **enriched in ^{15}N**

- **+5.3 to +7.2‰ (Manure)**
- **+9.3 to +20.9‰ (Compost)**

Soluble N fertilizers
(e.g. urea, ammonium salts)

→ **slightly depleted or slightly enriched in ^{15}N**

- **–3.9 to +0.5‰**

LIM, S-S., et al., Korean J. Soil Sci. Fert. 43 (2010) 453-457

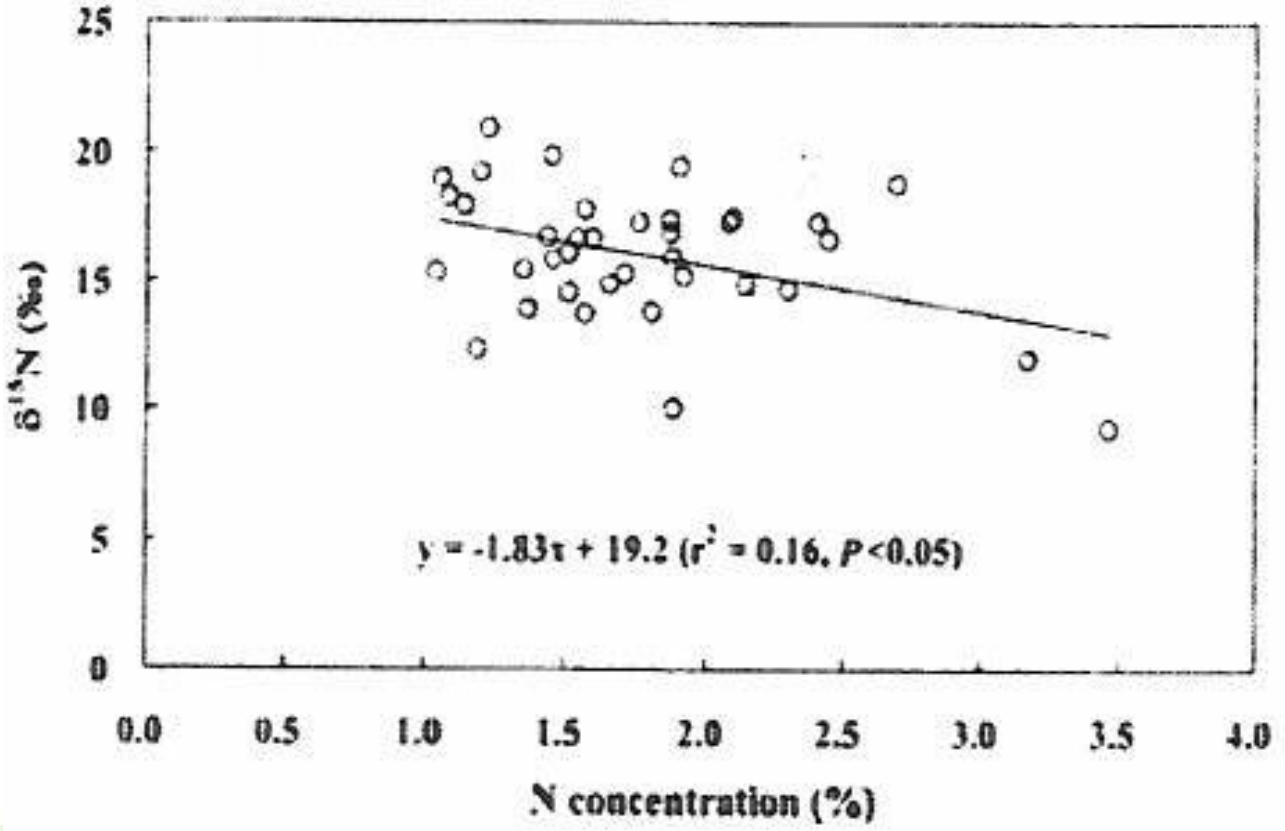
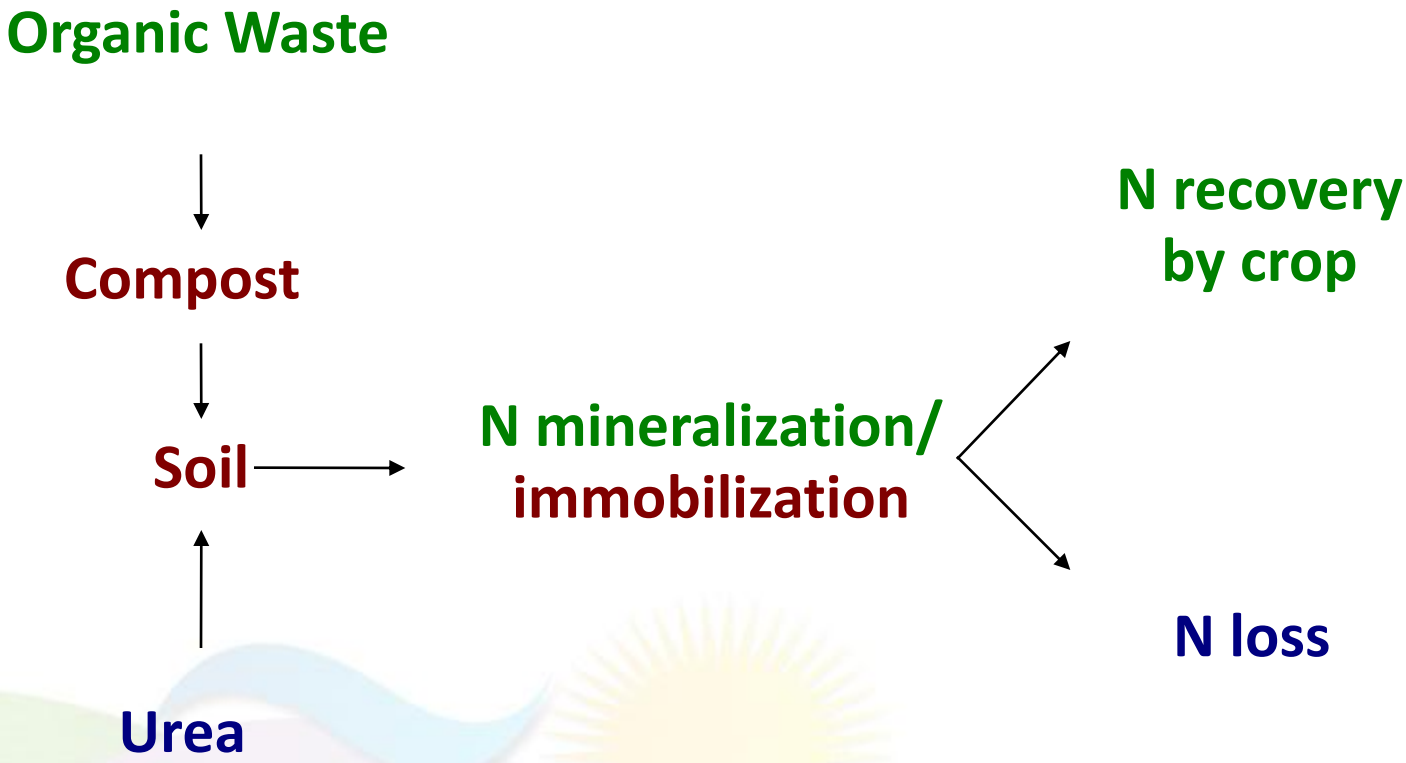


FIG. 2 Relationship between N concentration and corresponding $\delta^{15}N$ of livestock manure compost (n = 37)

LIM, S-S., et al., Korean J. Soil Sci. Fert. 43 (2010) 453-457

N fertilizer value of manure and derived compost



N recovery from compost vs. feedstock

Table 2 Recoveries of ^{15}N labelled residues and derived composts

Reference	Crop	Treatment[a]	C: N	g N m^{-2}	^{15}N[b]	Recovery (%)
Ghoneim (2008)	Paddy rice	Rice straw	45.2	2.71	8.08	16.6
		Rice straw compost	22.1		8.13	6.6
Kirchmann (1990)	Rye grass	Poultry manure	30.0	29	0.74	25.7
		PM + straw compost	14.9		0.73	3.8

[a]PM, poultry manure
[b]atom % excess

CHALK, P.M., et al., Plant Soil (2012) in press

Effect of compost on N fertilizer recovery

Table 3 Recoveries of ^{15}N labelled fertilizers by crops in the presence and absence of added composts

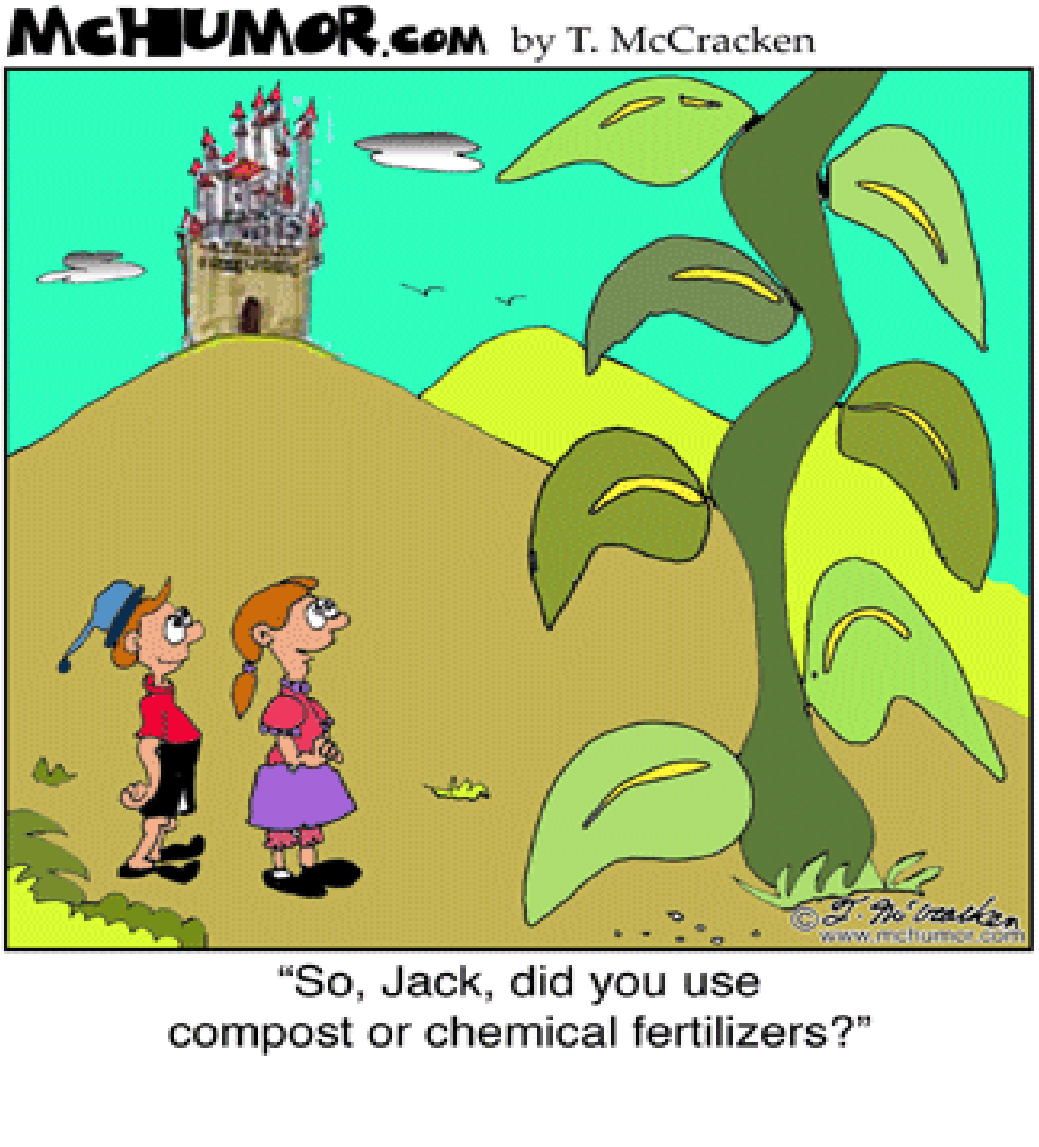
Reference	Crop	Compost	Fertilizer			
			Type	g N m^{-2}	$^{15}N^{a}$	Recovery (%)[b]
Choi et al. (2001)	Maize	–	Urea	15	5.804	49.6a
		+				39.7b
Choi et al. (2002b)	Chinese cabbage	–	Urea	45	4.874	15.1a
		+[c]				15.9a – 18.8b
Keeling et al. (2003)	Wheat	–	NH_4NO_3	17.5	10.0	40.8a
		+		7.0		60.9b
Takahashi et al. (2004b)	Paddy rice	–	$(NH_4)_2SO_4$	4.04	0.974	42.8a
		+				38.1b

[a]atom % ^{15}N excess

[b]Data within a column followed by a common letter are not significantly ($P<0.05$) different

[c]Compost was applied at the rate of 20, 40 and 60 g N m^{-2}

CHALK, P.M., et al., Plant Soil (2012) in press



$\delta^{15}N$ composition would appear to be a **promising marker** to distinguish organically- and conventionally-fertilized plant products

Organic vs. conventional product designation

Table 4 Statistical tests of differences in $\delta^{15}N$ composition between organic and conventional plant products

Product	$\delta^{15}N$ (‰)[a]		P[b]	Reference
	Organic	Conventional		
Tomato	+8.1 (3.2)	–0.1 (2.1)	**	Bateman et al., 2007
Lettuce	+7.6 (4.1)	+2.9 (4.3)	*	
Carrot	+5.7 (3.5)	+4.1 (2.6)	ns	
Orange fruit	+7.3 to +7.9	+ 5.1 to +6.1	***	Camin et al., 2011

[a]Data in parentheses are standard deviations of the mean

[b]* , P <0.05; **, P <0.01; ***, P<0.001; ns, not significant; --, no test applied

INACIO, C.T., et al., Crit. Rev. Food Sci. Nutr. (2013) in press

Conclusions

- Efforts to improve N fertilizer value of composts
- Natural ^{15}N abundance of compost as tracer
- Organic vs. Conventional $\delta^{15}N$ values

  complementary techniques + statistical tools

Thank You

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