Contribution of Manure Amendments to Soil Fertility and Carbon Sequestration

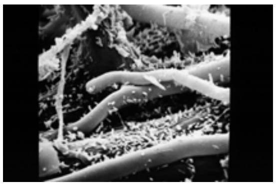
Animal wastes contain inorganic N (NH_4 + NO_3-N) and organic N:

- Inorganic N is plant available
- Organic N is mineralized by microorganisms before inorganic N can be released and used by plants
- Animal wastes increase plant available N in the season applied and add to pools of soil N and C that turnover in years or decades

The timing, availability and amount of inorganic N released from animal wastes is influenced by:

- Soil properties like texture, mineralogy, pH, cation exchange capacity
- Land Management: tillage and cropping system
- Long-term application of animal wastes

The type and size of microbial communities that mineralize organic N or transform inorganic N are partly determined by soil type and management



Nitrification

NH_4^+ → $N0_2^-$ → $N0_3^-$

Factors Affecting Nitrification

Initial nitrifier population size

Availability of nutrient source- NH_4^+

Soil Type

Humic materials in soil & animal waste

Ideal 60% water filled pore space

Anaerobic conditions with avail CO_2

Optimum pH 7 to 8

Inhibition of nitrification due to gaseous hydrocarbons (allelopathy)

Soil properties 0- 15-cm depth

Texture	Sand	Silt (%)†	Clay
silty clay loam	11	58	32
sandy loam	73	21	6.0
silty clay	19	41	40

†Soil separates measured via particle size determination (pipette methods).

Soil properties 0- 15-cm depth

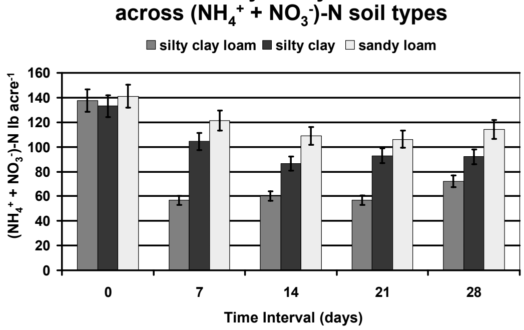
Texture	SOC† (%)	Total N‡ (%)	CEC§ ($cmol_c$ kg^{-1})
silty clay loam	3.5	0.25	31
sandy loam	0.58	0.06	10
silty clay	2.3	0.21	25

†SOC = soil organic carbon sample 0- 15-cm depth.
‡Total N = total soil nitrogen sample 0- 15-cm depth.
§Cation exchange capacity is ∑(Ca + Mg + K + Na) from the Mehlich III extract.

Dairy Slurry Manure Analysis

- Dairy slurry applications 39 ton $acre^{-1}$, <17% solids, pH 7.2 were incorporated
- Total Nitrogen content 268 lb N $acre^{-1}$
  152 lb N NH_4^+ -N $acre^{-1}$
  + 116 lb organic N $acre^{-1}$
- 39 lb P $acre^{-1}$

Effect of Dairy Slurry on Cumulative N across (NH_4^+ + NO_3^-)-N soil types



Soil Controls without Manure

Table 7.Correlation among soil properties, carbon, nitrogen, and nitrification potentials unmanured managements.

Nitrification Potentials (mg N kg soil d^{-1})	Cumulative N mineralized 28 d, (kg N ha^{-1})	Total C	Total N	C:N	pH	CEC	Sand	Silt	Clay
Day 0	-0.01	0.71**	0.72**	0.40	0.65*	0.83***	-0.53	0.18	0.68*
Day 7	-0.02	0.67*	0.70**	0.34	0.60	0.82***	-0.57	0.22	0.69*
Day 14	-0.10	0.67*	0.69*	0.35	0.68*	0.84***	-0.52	0.16	0.69*
Day 21	-0.02	0.63*	0.67*	0.28	0.60	0.81**	-0.54	0.16	0.70**
Day 28	-0.04	0.66*	0.70**	0.31	0.63*	0.82***	-0.57	0.21	0.70**

*** Significant at $P < 0.01$.
** Significant at $P < 0.05$.
* Significant at $P < 0.10$.

Manured Soils

Table 8.Correlation among soil properties, carbon, nitrogen, and nitrification potentials with application of dairy slurry.

Nitrification Potentials (mg N kg soil d^{-1})	Cumulative N mineralized 28 d, (kg N ha^{-1})	Total C	Total N	C:N	pH	CEC	Sand	Silt	Clay
Day 0	-0.04	0.72**	0.73*	0.40	0.74**	0.86***	-0.52	0.14	0.71**
Day 7	-0.32	0.76**	0.69*	0.63	0.70**	0.54	-0.34	0.33	0.19
Day 14	-0.39	0.01	0.07	-0.21	0.60	0.04	0.22	-0.20	-0.16
Day 21	-0.34	0.22	0.13	0.15	0.91***	0.40	0.23	-0.31	-0.04
Day 28	-0.34	0.70**	0.62*	0.54	0.87***	0.64*	-0.23	0.11	0.27

*** Significant at $P < 0.01$.
** Significant at $P < 0.05$.
* Significant at $P < 0.10$.

Several years of animal waste applications will increase the soil organic matter content, total C and N

Greater soil N will lead to increases in potentially mineralizable N, contributing to plant available N

Seasonal additions of animal wastes sequester or maintain soil carbon

Amendments containing significant amounts of humic material such as compost, add to C stocks and supply a limited amount of plant available N

The Living Field Lab (LFL) located in Kalamazoo MI was designed to compare the effects of Compost, crop rotations and cover crops on:

- the supply of inorganic N to row crops
- the size and mean residence time of C and N pools

Description of Experimental Units

Experiment	Management
Living Field Lab (LFL) previously in alfalfa	**Agronomic**
	Fertilizer
	Nitrogen fertilizer
	Compost
	Cropping System
	Continuous corn
	Rotation
	(Corn-corn-soybean-wheat)

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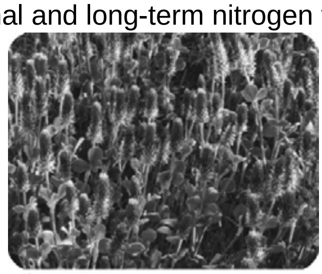
Supplementing compost applications with cover crops and legume rotations added to seasonal and long-term nitrogen fertility



Crimson clover

Above and below-ground C inputs derived from crop residues and compost

Crop	Carbon content of crop biomass (ton $acre^{-1}$) Fertilizer	Compost
Continuous Corn		
Total C Inputs 4 y	14	17
Rotation 4 y		
Total C Inputs 4 y	11	14

Crop	Field Available $(NH_4 + NO_3)$-N at 25 cm (ppm i) Fertilizer	Compost
Continuous Corn		
April	9.5 b	7.6 ab
July	21 c	6.8 ab
August	12 b	5.4 a
1st Corn after 4 yr Rotation		
April	3.3 a	14 b
July	34 d	9.0 b
August	19 c	10 b

Crop	Yields (ton $acre^{-1}$) Fertilizer	Compost
Continuous Corn		
Clover Cover Crop	2.8	2.5
No Cover	2.2	2.0
1st Corn after 4 yr Rotation		
Clover Cover Crop	3.0	2.9
No Cover	3.3	3.1

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Effect of N Source and Crop Diversity on: the Mean Residence Time of C and N pools

- Compost applications increase the N associated with humic material
- increasing the pool of soil organic N & the mean residence time of the pool
- A larger organic N pool increases the nitrogen mineralization potential (NMP)

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150-d N Incubation- N Pools after 4 yr of application

	Initial N (NO_3 + NH_4)-N	N Min Potential	Mean Residence Time
	(% inorganic N soil N^{-1})	(lb N $acre^{-1}$)	(Days)
Fertilizer Management			
Nitrogen Fertilizer	0.6	14	149
Compost	0.8	23	206

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Shifts in Total Soil Organic Carbon with 5 yr of Nutrient and Cropping Management

	(% total C in soil)
Baseline out of Alfalfa	0.94a
Nitrogen Fertilizer	1.15b
Compost	1.39c

Impact: Increased Carbon Sequestration and Fertility

Growers should design systems that increase cropping intensity and include application of organic amendments

Such a system could improve farmer profitability, sequester carbon and aid in the maintenance of soil fertility