Mending the "holes" in the "pipes" to reduce soil N_2O emissions from organic and inorganic fertilizer-based systems

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Since 1967 Science to cultivate change

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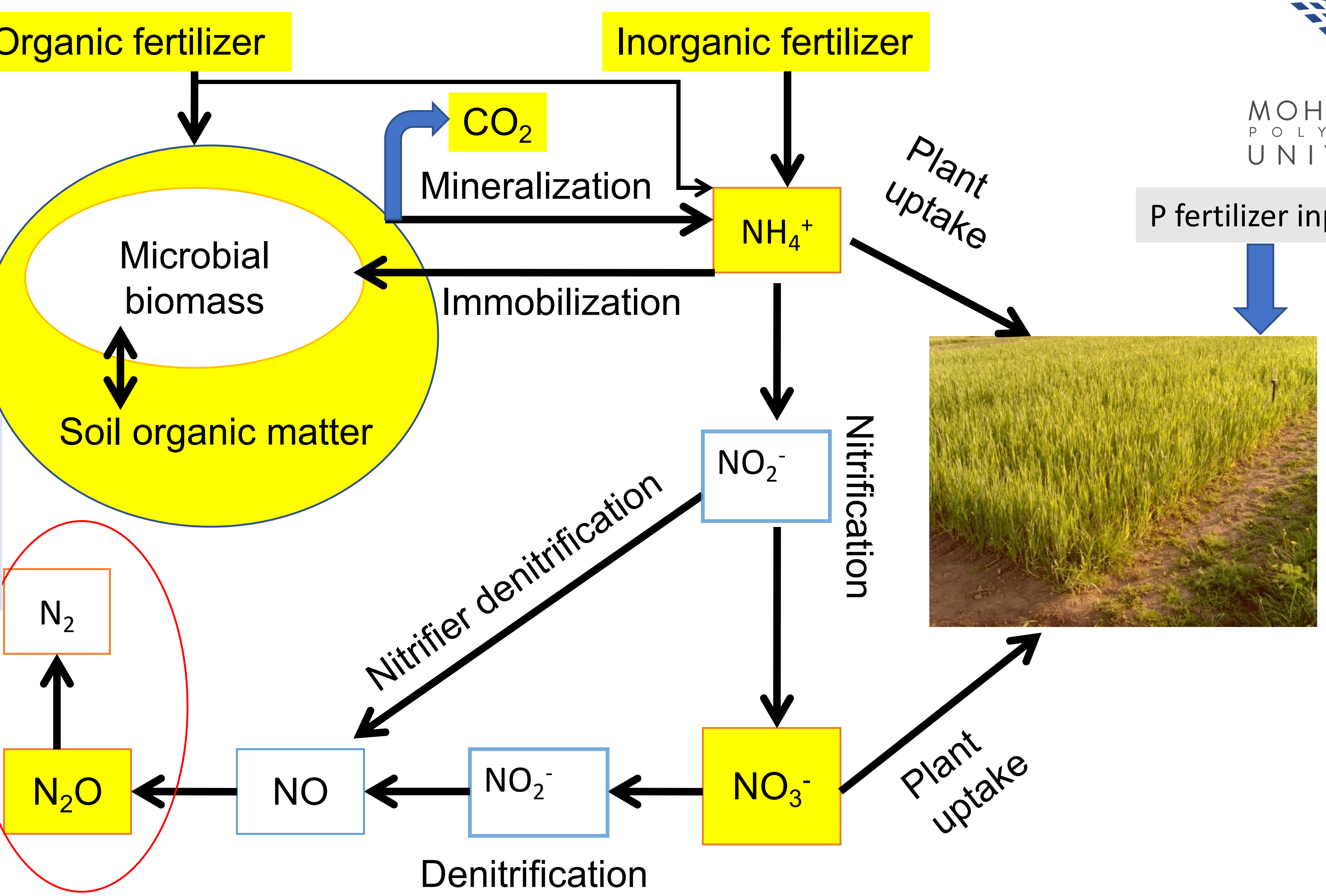
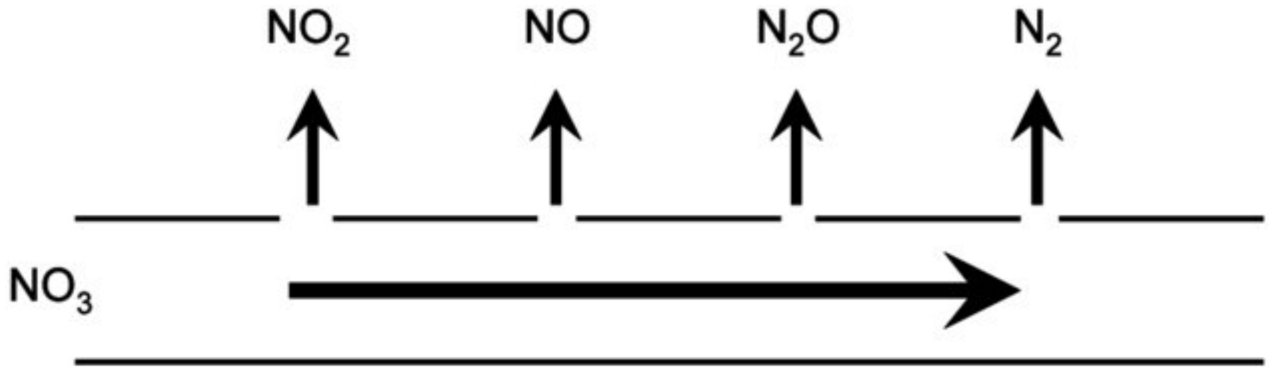
- C availability
- Anaerobicity
- Residence time
- NO_3^- availability



Hole-in-the-pipe model



Davidson et al., 2000

Denmark story: Winter wheat and Spring barley

Cropping systems in long-term Danish experiment

Conventional C4/+IF/-CC

spring barley → faba bean → potato → winter wheat

Organic O4/+M/+CC

spring barley^{CC} → faba bean^{CC} → potato → winter wheat^{CC}

Organic O2/+M/+CC

spring barley^{CC} → ley → potato → winter wheat^{CC}

Catch crops: Ryegrass, chicory, red and white clover
Ley: Ryegrass, red and white clover

Average C inputs in soils 2005-2007

Cropping systems	Average C inputs (Mg C ha^{-1})	Average N inputs (kg N y^{-1})	N inputs for winter wheat (kg N ha^{-1})
C4/+IF/-CC	2.20[a]	109 (NH_4NO_3)	165
O4/+M/+CC	2.48[a]	70 (untreated pig slurry)	108
O2/+M/+CC	3.39[b]	70 (anaerobically digested pig slurry)	102

Winter wheat yields 2008

System	Spring barley ($t\ ha^{-1}$)
C4/+IF/−CC (inorganic fertilizer)	9.5[a]
O4/+M/+CC (untreated)	6.3[b]
O2/+M/+CC (anaerobically digested)	5.8[b]

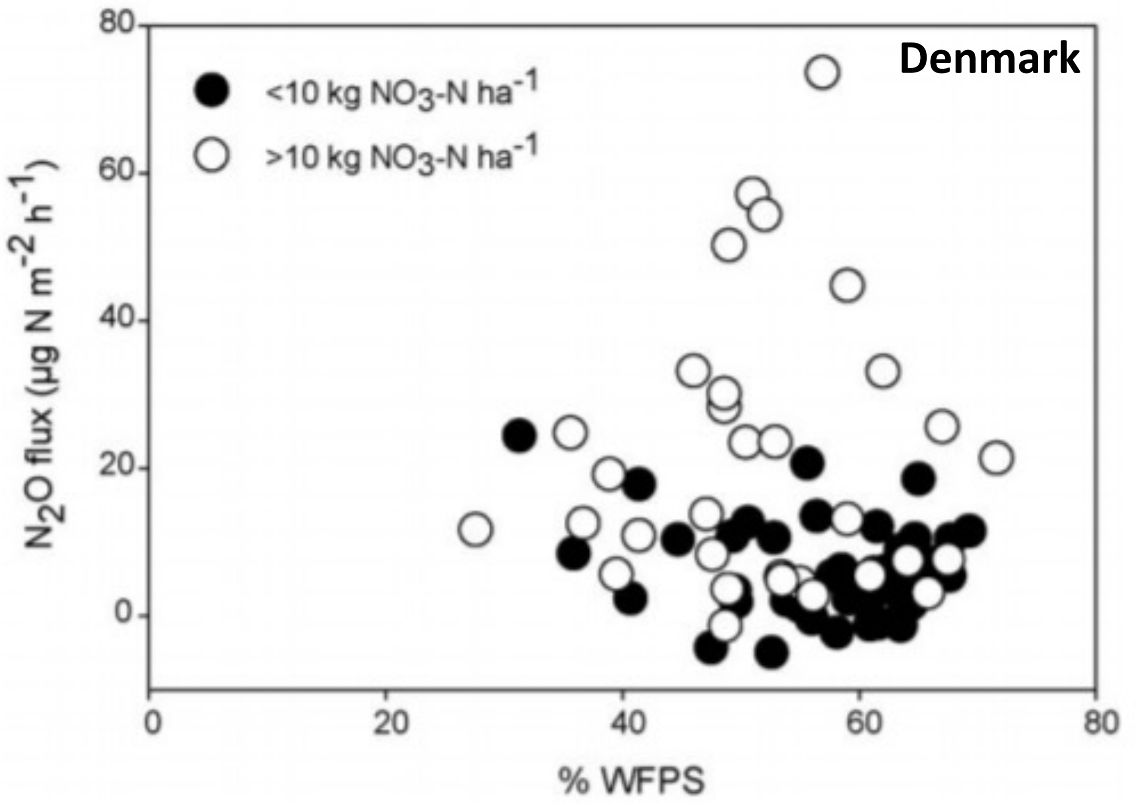
Cropping season N_2O emissions

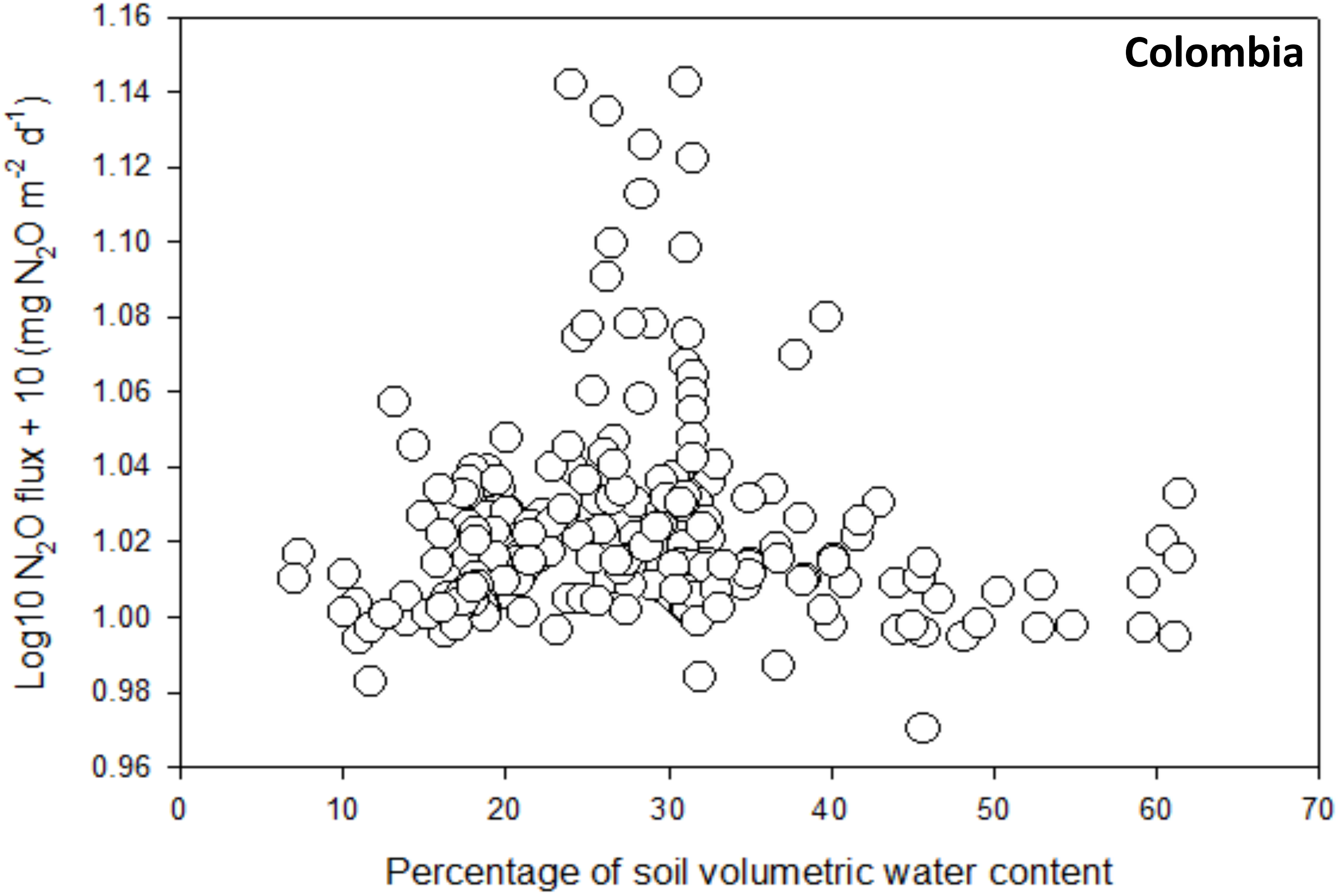
Cropping systems	Cumulative soil N_2O emissions (kg N_2O-N ha^{-1})	Emissions per N applied (kg N_2O-N 100 kg^{-1} N)
C4/+IF/-CC	0.92[a]	0.56[a]
O4/+M/+CC	0.81[a]	0.75[b]
O2/+M/+CC	0.63[a]	0.62[b]

Colombia story: Cassava

Treatment	Applied N (kg ha^{-1})	Nitrate-intensity (g N kg dry $soil^{-1}$)	Cumulative soil N_2O emissions (kg N_2O-N ha^{-1})	Emission Factor (%)
Control	0	1.84	0.58[a]	
Organic fertilizer (vermicompost)	49.8	2.15	1.28[a]	1.39
Inorganic fertilizer (NH_4NO_3)	22.7	3.78	1.74[b]	5.1

Drivers of N_2O emissions





Key take home message

- **N source may have a more substantial influence on N_2O emissions than N applied** under tropical climates (i.e., Colombia): Applied N higher in organic fertilizer amended soils – emissions lower.

- Under temperate conditions (i.e., Denmark): **No difference in N_2O emissions between organic and inorganic but N inputs higher in inorganic fertilizer systems**

- Denmark: **Low yields achieved with organic farming practices without a corresponding reduction in N_2O emissions**.

- Need for improving **N management strategies** to avoid surplus N in soil.

References

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