Organic Sources of Nutrients

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What are Organic Sources of Nutrients?

- Livestock and poultry manure
- Biosolids (wastewater sewage sludge)
- Water treatment residuals (alum sludge)
- Industrial sludge

Benefits of Waste Amendments

- Nutrients
  - N, P, K
  - Secondary & trace elements
- Organic matter
  - Soil physical properties
  - Soil chemical properties
  - Soil biological properties
- Lime

Organic Amendments and Water Quality

- Slow release N - reduce or increase water contamination risk
- N:P imbalance - environmentally detrimental soil P concentrations
- Increased soil infiltration reduces runoff
- Increased water-holding capacity increases biomass production and nutrient utilization

Characteristics of Manure

- Nitrogen (N)
  - urea → NH_3/NH_4^+
  - organic compounds → NH_4^+ → NO_3^-
- Phosphorus
  - Organic compounds → inorganic (HPO_4^{2-}, $H_2PO_4^-$)

Characteristics of Manure

- Potassium (K^+)
  - soluble K ion
- Secondary nutrients (Ca^{2+}, Mg^{2+}, SO_4^{2-})
- Trace elements
  - AsO_4^{3-}, Zn^{2+}, Mn^{2+}, Cu^{2+}, Fe^{2+}, H_3BO_3, MoO_4^{2-}

Nitrogen Losses During Handling

System	Nitrogen lost (%)
Daily scrape & haul	15-35
Open lot	40-60
Earthen storage	20-40
Lagoon	70-80

Avg. Liquid Manure Composition

Source	TKN	NH_4	P_2O_5	K_2O	Moisture
	Lbs/1000 gals				%
Dairy	19	9	9	17	95
Swine:					
-lagoon	7	6	3	12	99
-pit	24	15	17	16	97

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Nutrient Content of Solid Manures

Type	TKN	NH_4	P_2O_5	K_2O
	Lbs/ton			
Dairy	15	3	8	14
Beef	18	2	10	19
Turkey	62	13	50	38
Layer	48	9	61	44
Broiler	65	11.5	52	53

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Is Manure Sampling and Testing Important?

Characteristics of Biosolids

- Nitrogen (N)
  - inorganic (NH_4^+/NH_3)
  - organic
- Phosphorus ($H_2PO_4^-$, HPO_4^{2-})
  - inorganic complexed with Fe oxides

Characteristics of Biosolids

- Potassium (K^+)
  - soluble K lost in wastewater effluent
- Secondary nutrients (Ca, Mg, S)
- Calcium carbonate equivalent (lime value)
- Trace elements
  - Mn, Fe, B, Mo, Cu, Zn
  - As, Cd, Pb, Hg, Ni, Se

Avg. Biosolids Composition

Nutrient	Aerobic digestion	Anaerobic digestion	Alkaline stabilization
	%		
TKN	4.9	4.6	3.7
NH_4-N	0.2	0.9	0.1
P	2.4	2.1	1.3
K	0.4	0.5	0.2

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Elemental Content of Other Sludges

Type	TKN	P	K
	%		
Textile	2.8	0.9	0.2
Fermentation	3.5	0.2	0.1
Paper mill	0.4	0.1	0.1
Alum	0.7	0.4	2.0

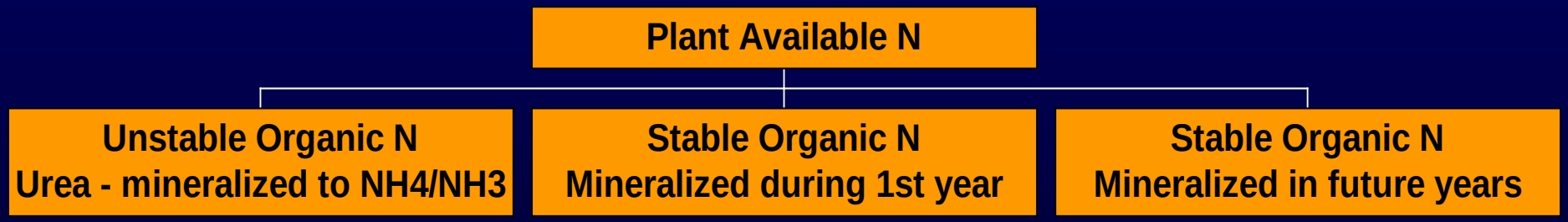
Calculating Application Rates

- N-based
  - supply PAN for specific crop and soil
- P-based
  - supply crop P needs
- Lime-based (biosolids)
  - adjust coarse-textured soils to pH 6.5

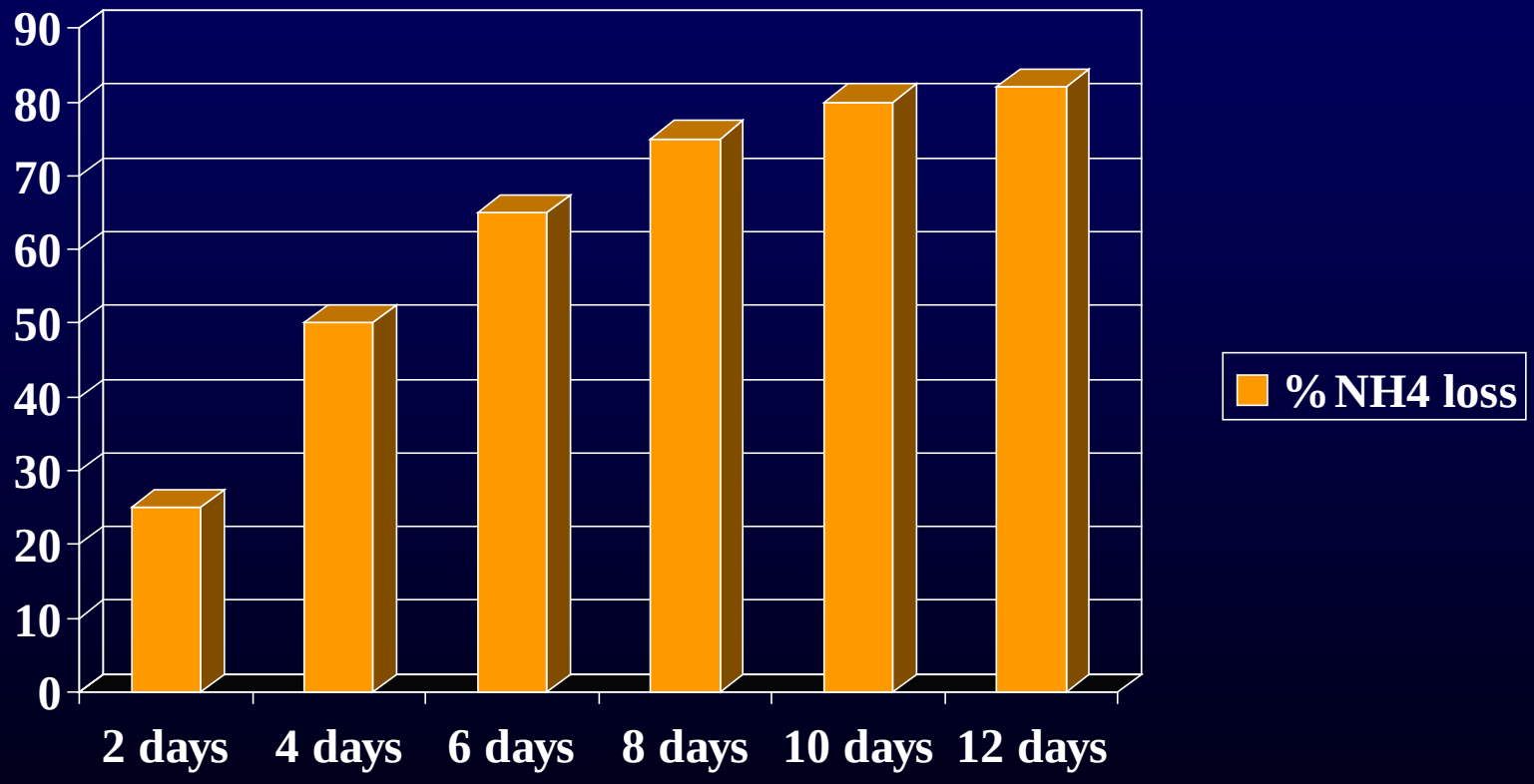
Factors Influencing Plant Available N

- Inorganic N availability
  - NH_3 volatilization
- Organic N mineralization
  - C:N ratio
  - Organic N forms

PAN Fractions in Manure



Loss of NH_4-N after surface application of dairy manure



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Manure NH_4-N Availability Coefficients

Incorp. timing	Lagoon liquid	Slurry	Semi-solid	Dry
Injection	0.95	0.95		
Inc.<1d	0.90	0.75	0.75	0.90
Inc.>2 d	0.80	0.65	0.65	0.80
Inc.>4d	0.60	0.40	0.40	0.65
Inc.>7d	0.45	0.25	0.25	0.50

Biosolids NH_4-N Availability Coefficients

Application method	Biosolids pH<10	Biosolids pH>10
Injection	1.00	1.00
Incorporation w/in 24 hrs	0.85	0.75
Incorporation w/in 1-7 d	0.70	0.50
Incorporation after 7d	0.50	0.25

Organic N Mineralization Coefficients for Manure

Manure type	Spring/Early Fall/ perennial grass	Winter topdress/ spring residual
Dairy	0.35	0.20/0.15
Swine	0.50	0.25/0.25
Poultry	0.60	0.30/0.30

Organic N Mineralization Coefficients for Biosolids

Biosolids treatment	Years after application		
	0-1	1-2	2-3
Lime stab.	0.30	0.10	0.10
Aer. Digest	0.30	0.10	0.10
Anr. Digest	0.30	0.10	0.10
Compost	0.15	0.05	0.03

Estimating N Availability

- Sum of:
  - Inorganic N - NH_3 volatilized
  - Organic N * First year mineralization coefficient
  - Residual N (2nd yr + 3rd yr +...ith yr)