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Nitrogen - A harmful or a beneficial compost property?

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Structure

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1. Introduction
- Global N-Cycle
- N as fertilizer
- N pollution

2. Material and Methods
- Composting facility
- Composting set-up
- Composting phases
- N-measurement

3. Results
- N-compounds in the substrate
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4. Discussion & Conclusions
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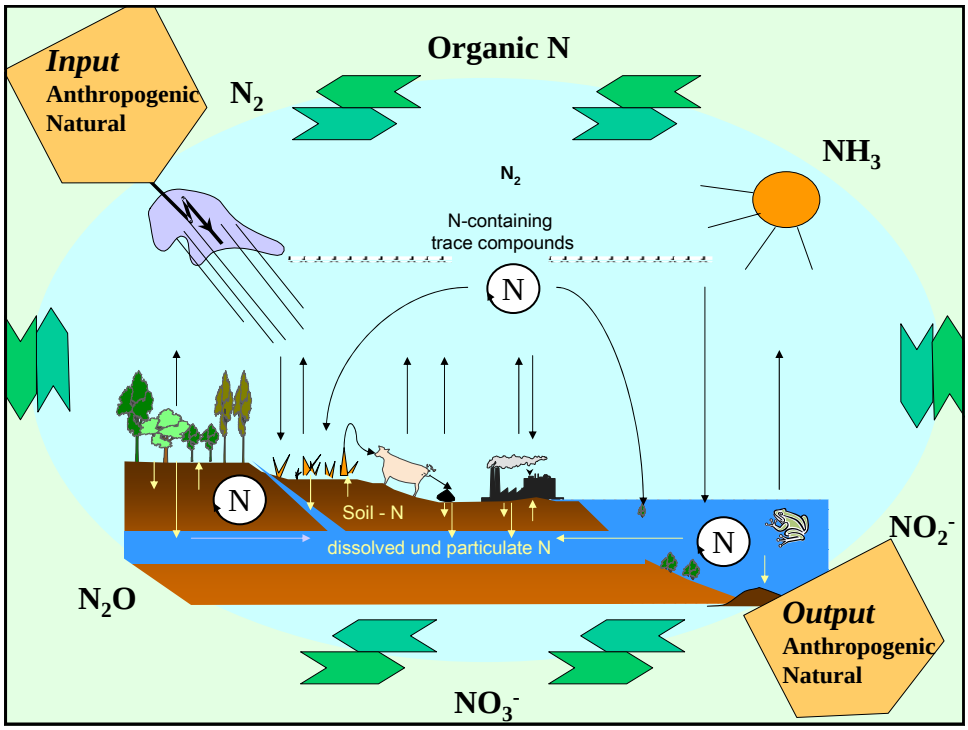
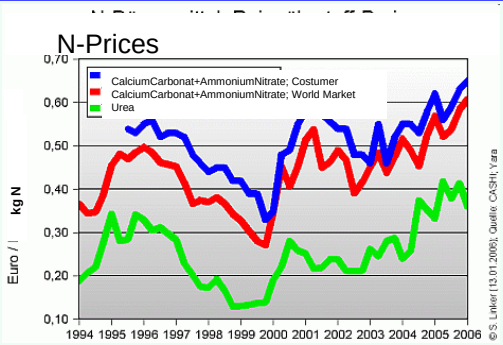
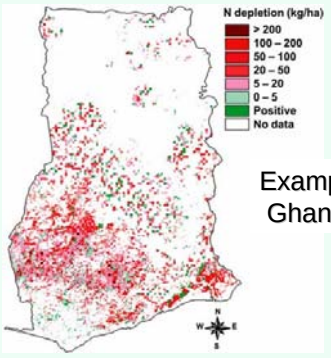


N as fertilizer





- N-Deficites in many regions
- Increasing Production of Mineral Fertilizers
- Increasing Prices due to Energy Price Increases

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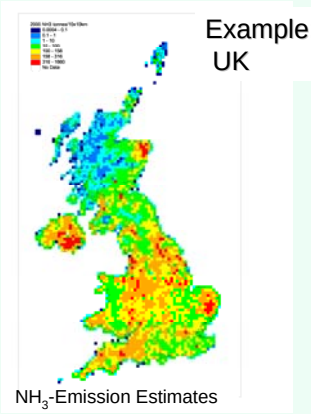
N - pollution

- **Eutrophication (soluble N)**
- **Fish toxicity (NH_3)**
- **Toxic / cancerogenic to Humans (NO_3^-/NO_2^-in drinking water)**
- **Odour nuicance (NH_3)**
- **Over-fertilization (soluble N)**
- **Climate impact (N_2O)**



NH_3-Emission Estimates

www.airquality.co.uk/archive/2008/shap5.html

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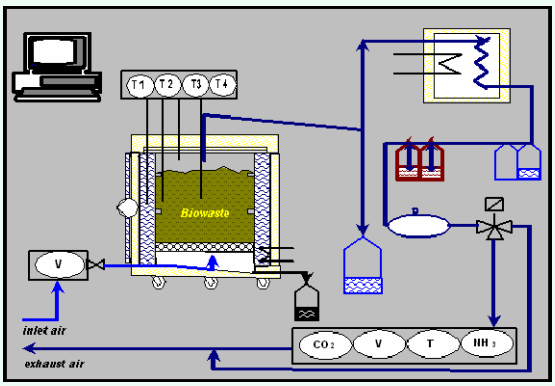
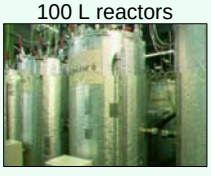
Composting Unit

To determine behaviour of N under lab-scale conditions:



100 L reactors



Periphere equipment

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Composting Experiments






53 experiments with variation of

- **Input materials**

Source separated wastes; Mixed MSW; Green wastes; Chicken manure; Sewage sludges

Modell wastes

- **Process regulation**

Aeration, Turning, Temperature

Moisture, Structure, pH

- **Time**

Between 3 and 60 weeks

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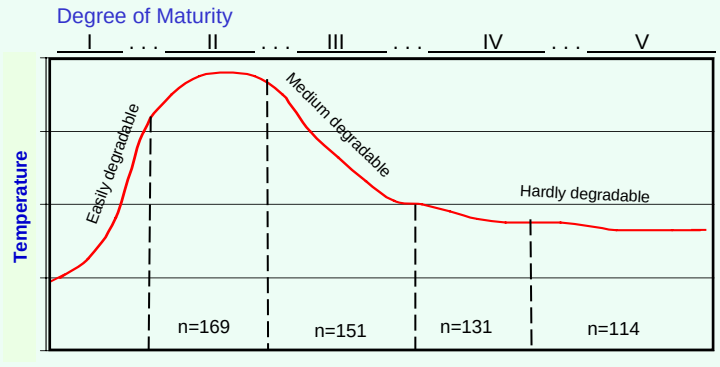
Composting phases



Phase 1: Maximum temperatures

Phase 2: Decreasing temperatures

Phase 3: First Month of maturation

Phases 4-7: More than one month of maturation

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Measurements and Analytics

N in the substrate:

- Organic N
- Ammonia/Ammonium-N
- Nitrate N
- Nitrite N

Milieu conditions:

- Water Content
- pH value
- Temperature
- Organic Content
- Bulk density
- Gas composition

Released N

- Exhaust Air: Ammonia N
- Exhaust Air: N_2 and N_2O
- Leachate: Total N

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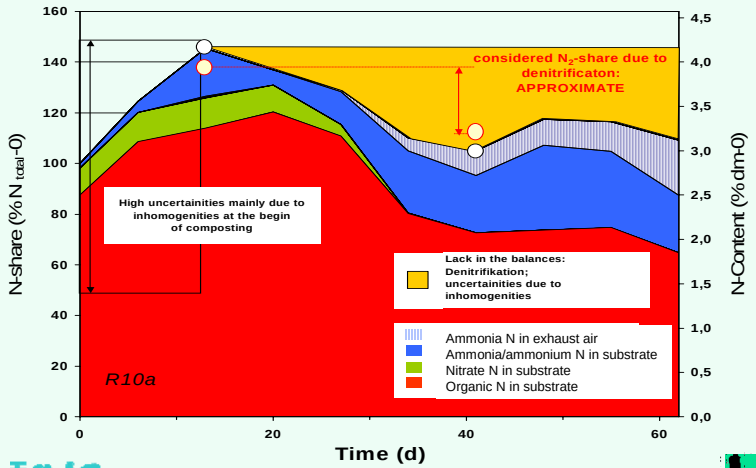
N measurement



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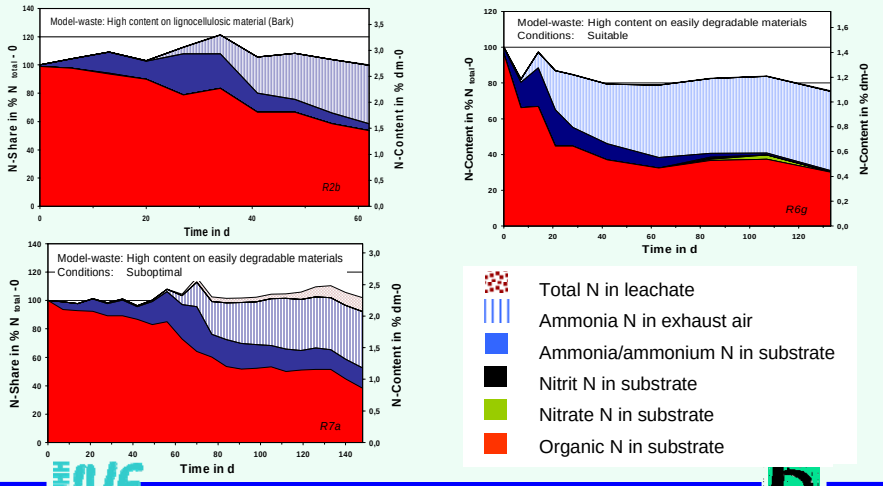
N-Balances

-Examples-



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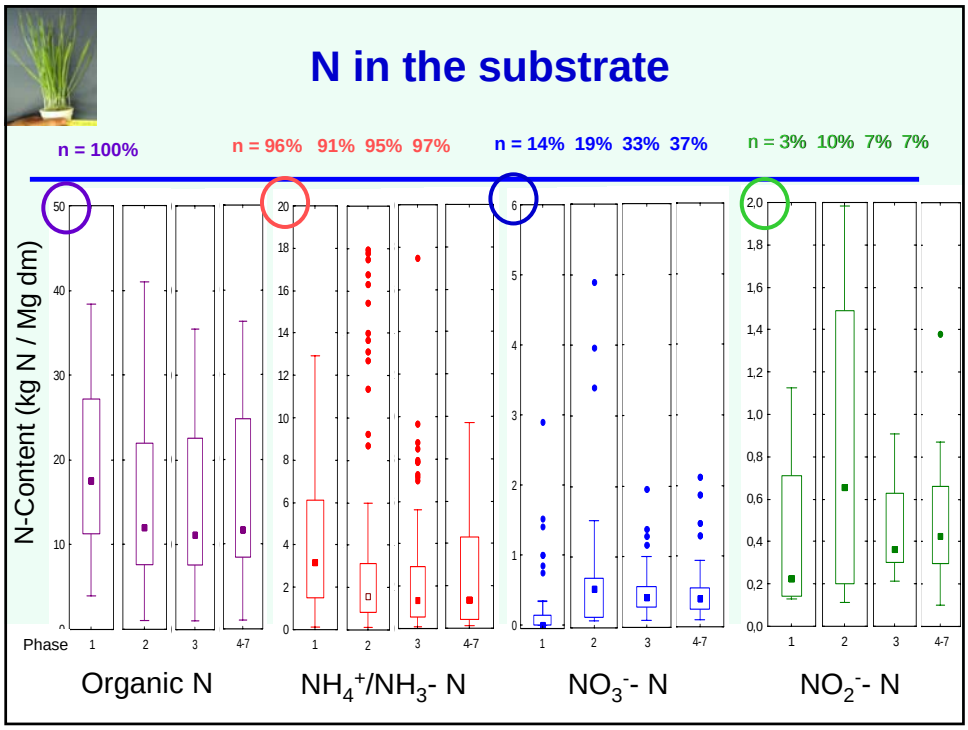
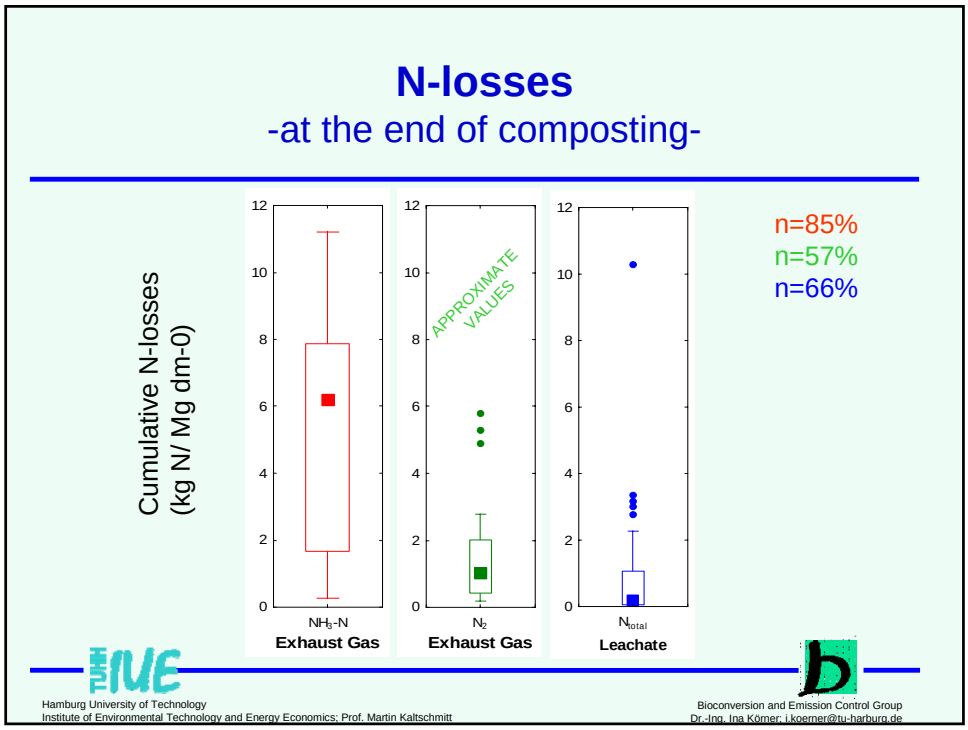

N in the substrate
n = 100%
n = 96% 91% 95% 97%
n = 14% 19% 33% 37%
n = 3% 10% 7% 7%
N-Content (kg N / Mg dm)
Phase
Organic N
NH4+/NH3- N
NO3--N
NO2--N


N-losses
-at the end of composting-
Cumulative N-losses
(kg N/ Mg dm-0)
NH3-N
Exhaust Gas
N2
Exhaust Gas
Ntotal
Leachate
APPROXIMATE VALUES
n=85%
n=57%
n=66%
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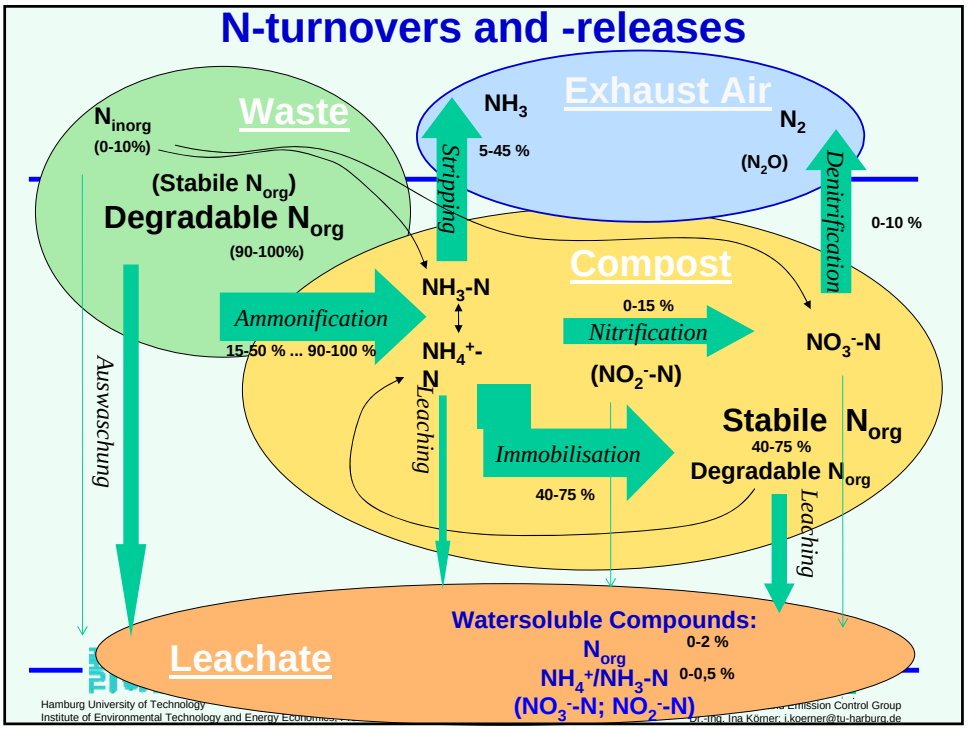
N-turnovers and -releases



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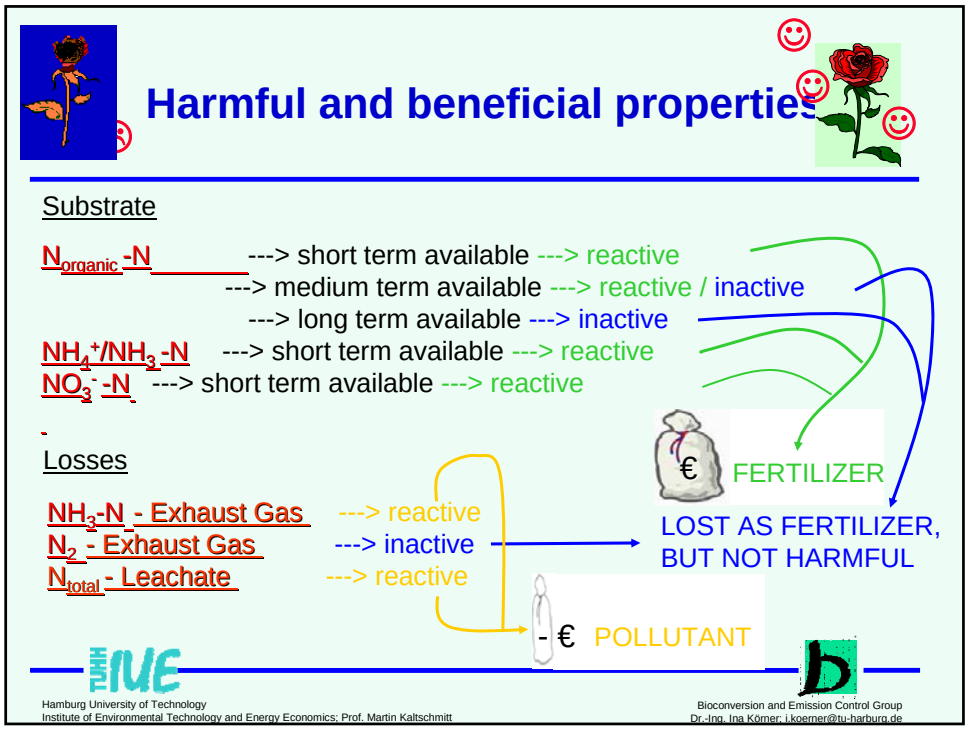
Harmful and beneficial properties
Substrate
$N_{organic}$-N ---> short term available ---> reactive
---> medium term available ---> reactive / inactive
---> long term available ---> inactive
NH_4^+/NH_3-N ---> short term available ---> reactive
NO_3^--N ---> short term available ---> reactive
Losses
NH_3-N - Exhaust Gas ---> reactive
N_2 - Exhaust Gas ---> inactive
N_{total} - Leachate ---> reactive
€ FERTILIZER
LOST AS FERTILIZER, BUT NOT HARMFUL
- € POLLUTANT
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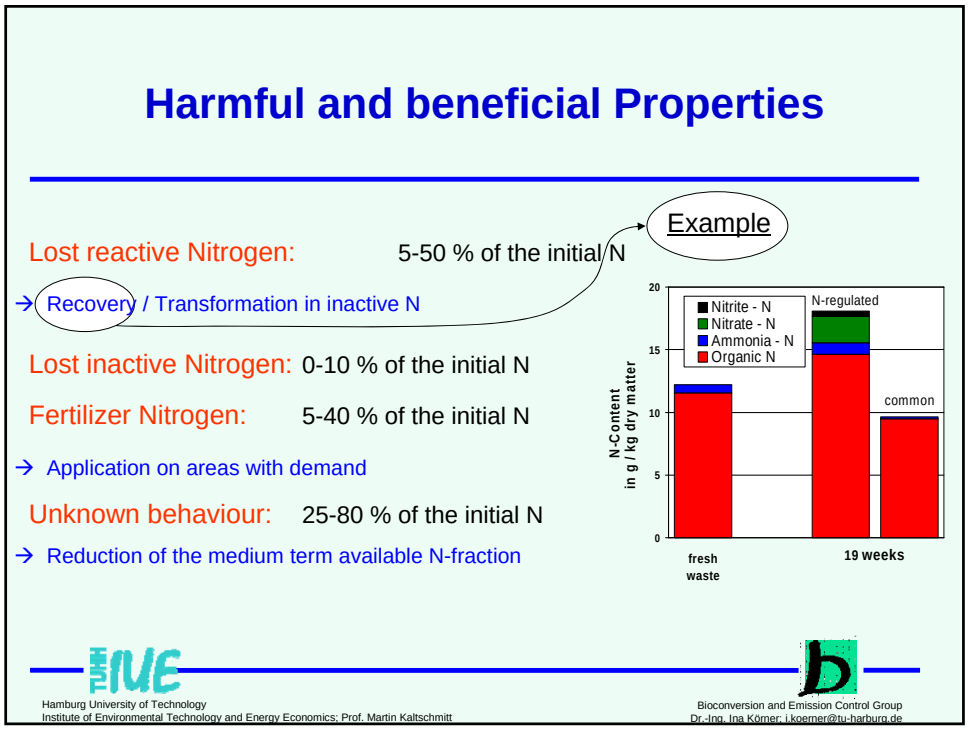
Harmful and beneficial Properties
Lost reactive Nitrogen: 5-50 % of the initial N
Example
→ Recovery / Transformation in inactive N
Lost inactive Nitrogen: 0-10 % of the initial N
Fertilizer Nitrogen: 5-40 % of the initial N
→ Application on areas with demand
Unknown behaviour: 25-80 % of the initial N
→ Reduction of the medium term available N-fraction
Nitrite - N
Nitrate - N
Ammonia - N
Organic N
N-regulated
common
N-Content in g / kg dry matter
fresh waste
19 weeks
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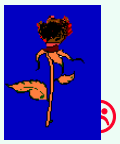

CASE STUDY GERMANY

Treated in composting facilities - 8 Mio. Mg wet organic waste[1]
(4 Mio. Mg dry matter)

Estimated Fertilizer Price - 0.6 €/kg N

1 based on data from ECN, 2006

Calculations with mean values from the experiments

Polluting potential / Losses:

Leachate-N:	0.1 kg N / Mg dm =0.06 € / Mg dm	38 Mio. €/a
Exhaust-Gas-NH_3-N:	5.3 kg N / Mg dm =3.18 € / Mg dm	
Exhaust-Gas-N_2 :	0.3 kg N / Mg dm =0.18 € / Mg dm	
Medium / Long term N_{org}:	10.0 kg N/ Mg dm =6.00 € / Mg dm[2]	

Fertilizer value:

NH_4^+/NH_3-N:	1.3 kg N / Mg dm = 0.78 €/Mg dm	19 Mio. €/a
NO_3^--N:	0.4 kg N / Mg dm = 0.24 €/Mg dm	
Short term N_{org} :	2.2 kg N / Mg dm = 3.67 €/Mg dm[2]	

2 Estimation

Conclusion

Pollutant effect ☹ **Fertilizing effect ☺**

All pollutant effects can be avoided.
Fertilizing effect could be used much better.
Easy Analytics for determination of short/medium/long term N is needed.

No measures for N-Regulation
are practiced today !

N-Cycle during composting provides options for N-regulation.

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