Mineral concentrate from processed manure as fertiliser

Gerard Velthof

P. Hoeksma , J.J., Schröder, J.C. van Middelkoop, W. van Geel, P.A.I. Ehlert, G. Holshof, G. Klop, and J.P. Lesschen

ALTERRA WAGENINGEN UR

INTERREG IVB

BIOREFINE

Outline

- Introduction: Pilot Mineral Concentrates
- Production and composition of mineral concentrates
- Agricultural effects
- Environmental effects
- Legal aspects
- Conclusions

ALTERRA WAGENINGEN UR

Manure policy in the Netherlands

- EU Nitrates Directive: decrease N leaching to groundwater and eutrophication of surface waters
- Three application standards in the Netherlands
  - Effective N in manure and fertilizers
  - Total P in manure and fertilisers
  - Total N in manure
- The manure standard limits the use of manure in NL

  → manure has to be treated, incinerated or exported

  → replacement of artificial fertilisers by mineral concentrates from processed manure?

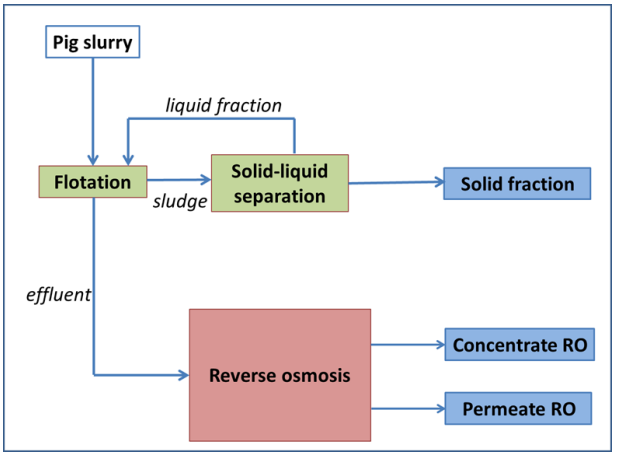
ALTERRA WAGENINGEN UR

Pilot mineral concentrate

- Mineral concentrate is produced by reverse osmosis of the liquid fraction of separated pig or cattle slurry
  - Liquid N-K fertiliser with low organic matter content
- Has a mineral concentrate produced from manure the same properties as mineral fertiliser?
- A pilot is carried out in which mineral concentrates are produced and used as a mineral fertiliser
  - 10 production plants
  - 100 – 200 users of concentrate
  - Research (desk, laboratory, field)

ALTERRA WAGENINGEN UR

Production of mineral concentrate



ALTERRA WAGENINGEN UR

End products

Mineral concentrate
Liquid N-K fertiliser

Solid fraction
P fertiliser
Organic N fertiliser
Soil conditioner

Permeate
(water)

ALTERRA WAGENINGEN UR

Mass balances of treatment plants

Mass balances (input = 100%)					
		N	NH4-N	P	K
Input	pig slurry	100	100	100	100
Output	solid fraction	44	29	96	18
	concentrate	53	70	4	78
	permeate	2	0	0	1
Balance (input-output)		1	1	0	3

Hoeksma and Buisonjé (2012)

ALTERRA WAGENINGEN UR

Composition of mineral concentrates (2011)

	Average of 4 installations g/kg product	Sd. g/kg product
Dry matter	36.9	9.18
Organic matter	14.0	3.97
Total N	8.15	1.58
NH_4–N	7.51	1.66
P	0.16	0.11
K	8.02	1.27
pH	7.96	0.17
EC	59.8	7.47
Volatile fatty acids	3.30	3.24

ALTERRA WAGENINGEN UR

Hoeksma and Buisonjé (2012)

Pot experiments

Nitrogen Fertilizer Replacement Value, % compared to Calcium Ammonium Nitrate

Fertiliser	Swiss chard		Grass	
	Clay	Sand	Clay	Sand
Mineral concentrate 1	78	96	93	97
Mineral concentrate 2	82	89	80	76
Pig slurry	67	76	73	71

Ehlert et al. (2012)

ALTERRA WAGENINGEN UR

Pot experiments

NFRV, % compared to CAN

Fertiliser	Surface-applied	Injected
Mineral concentrate 3	62	92
Mineral concentrate 4	36	-*
Pig slurry	41	75

Klop et al. (2012)

ALTERRA WAGENINGEN UR

Summary experiments arable land

Average NFRV, % compared to CAN

Crop	Soil	Year	
Potato	Clay	2009	75
Potato	Sand	2009	84
Potato	Clay	2010	76
Potato	Sand	2010	81
Maize	Sand	2010	72
Maize	Sand	2011	84

Schröder et al. (2012)

ALTERRA WAGENINGEN UR

Summary results experiments grassland

Average NFRV, % compared to CAN

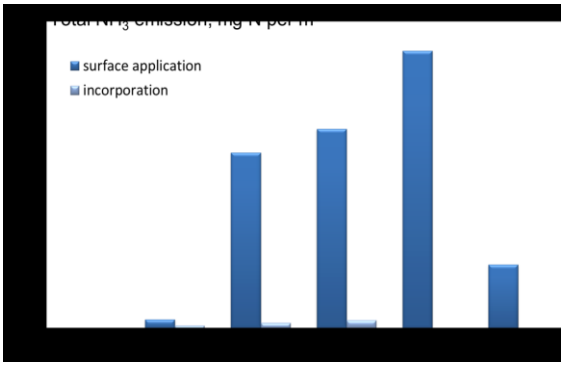
Year	Fertiliser	Soil	Reference fertiliser	
			CAN	Liquid AN
2009	Mineral concentrate	Sand/clay	54	86
2010	Mineral concentrate	Sand/clay	71	102
2011	Mineral concentrate	Sand	80	79
2011	Diluted mineral concentrate	Sand	91	89

Middelkoop and Holshof (2012)

ALTERRA WAGENINGEN UR

Ammonia emission

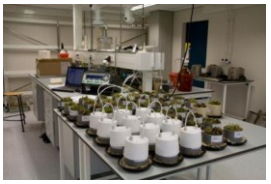
- Concentrate: high ammonium content and pH:
  - High ammonia emission when surface-applied
  - Incorporation/injection in soil reduces emission

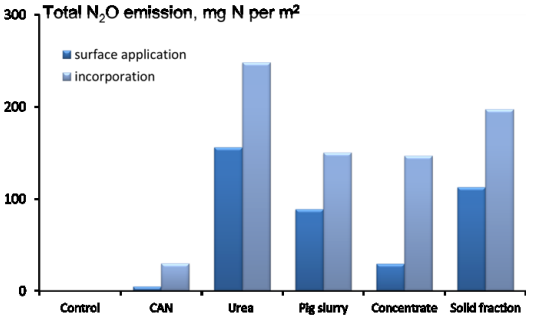


Velthof and Hummelink (2012)

Nitrous oxide emission

- Relative high compared to CAN
  - Denitrification: presence of organic C in concentrate, such as volatile fatty acids
  - Nitrification: ammonia toxicity

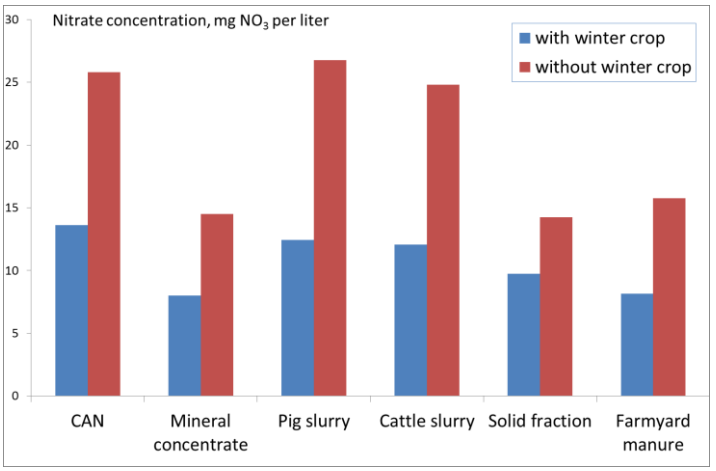




Velthof and Hummelink (2012)

Nitrate leaching

Average nitrate concentration upper groundwater in maize experiments in 2010 and 2011



Schröder et al. (2012)

ALTERRA WAGENINGEN UR

Heavy metal and organic pollutants

Contents of heavy metals and organic micro-pollutants are below the norms of the Dutch Fertiliser Act

- Cu, Zn, Cd, Cr, Ni, Pb and As
- dioxins, non-ortho PCBs, mono-ortho PCBs, indicator PCBs, PAHs, organochlorine pesticides and mineral oil

ALTERRA WAGENINGEN UR

Legal aspects

- EU Nitrates Directive
  - Concentrates are produced from manure → manure
  - Discussion with European Commission about N fertiliser value and environmental effects

- EU Fertiliser regulation 2003/2003
  - Concentrates do not meet requirements
    - N and K contents are too low
    - nutrients from animal excreta
  - Regulation is currently under revision and possibility to include new products

ALTERRA WAGENINGEN UR

Conclusions

- Mineral concentrate: liquid N –K fertiliser produced from manure
  - NFRV compared to CAN about 80% in field experiments (but large variation: 54 to more than 100%)
  - NFRV up to 100% in pot experiments

- Fate of non-effective N:
  - Gaseous losses: ammonia and denitrification
  - No increase in N leaching

ALTERRA WAGENINGEN UR

Thank you