Animal feeding and environmental impact for pig production; the Dutch case

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Paul Bikker

Introduction

- Background and overview of the manure policy system
- Production and (allowed) use of animal manure
- Calculation of N,P excretion
  - N,P intake feed – N,P retention in the body
  - Some scientific data
- Example of national excretion
- Other relevant legislation
- Summary and conclusions

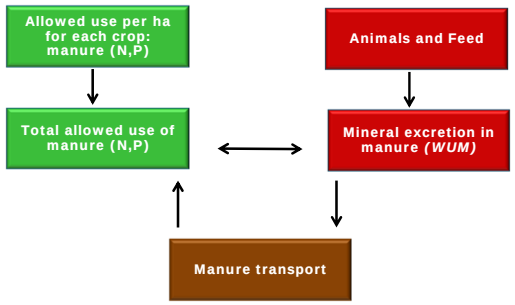
Environmental impact of pig production

- Phosphate
  - Use of limited resources of rock phosphate
  - Accumulation of P in soil
  - **Run-off into surface water → eutrophication**
- Nitrogen
  - Ammonia emission
  - Accumulation of N in the soil
  - **Run-off into surface water → eutrophication**
  - **Nitrate in ground and drinking water**

Present manure policy (2006)

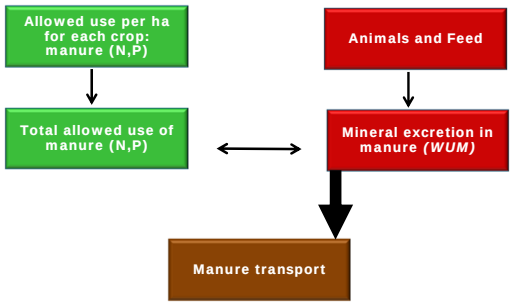
- Previous system (MINAS) was not accepted by EU to meet nitrate directive for water quality
  - Based on acceptable losses (output – input/ha) into environment → insight in efficiency
- Present system introduced in 2006
- Leading principle: N and P application to the grassland and cropland
  - Max. animal manure, based on N (EU directive)
  - Max. total N (manure and fertiliser)
  - Max. total P (manure and fertiliser)

Overview manure policy: general



Use of manure, N & P should not exceed max. allowance on each farm

Overview manure policy: pigs farms



Use of manure, N & P should not exceed max. allowance on each farm

Allowance of manure and fertiliser

Expressed per ha

- Animal manure
  - Max. 170 kg N/ha (except derogation)
- Total N
  - Depending on soil type (n=5) and crop (n~150)
  - From 30 (peas) - 385 (grassland, mowing) kg N/ha
- Total P (as phosphate, P_2O_5)
  - Grassland (80 kg) or arable land (50 kg)
  - Higher for low-P soils (to be demonstrated)
- For pig manure, generally P-content determines max.
- At all farms usage must be with legal limits

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Usage of manure and fertiliser

Annual calculation

+ Production of animal manure (N, P)

+ Import of manure (fertiliser) to the farm

-/- Export of manure (fertiliser) from the farm

(+ correction of stock changes)

= total usage of manure (fertiliser) on the farm

Should not exceed legal limits/ha (manure, N, and P)

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Usage of manure, farm without land

Simplified calculation

Production of animal manure (N, P)
minus
Export of manure from the farm

= total usage of manure on the farm

Must be close to zero for a farm without land

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Production of animal manure (pigs)

Simplified balance method

Manure production (N, P) =
Input of N,P in feed – Retention of N, P in pigs

The NL system does not use fixed excretion factors!

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Production of animal manure (pigs)

Opening stock (1 January)	Closing stock (31 December)
N, P in animals	N, P in animals
N, P in feed	N, P in feed
Import N, P in pigs	**Export N, P in pigs**
Import N, P in feed	**Export N, P in feed**
N, P in home grown feed	
	Correction gaseous N losses
Sum input	Sum output
Manure production = sum input – output	

- Note: calculation on farm basis; distribution among types of animals is less important

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Calculation of N, P in feed for pigs

- Supply of each feed (kg) with N, P contents (g/kg) is documented by registered feed suppliers
  - Farmer, for each delivery and annual total
  - National authorities
- Home grown or obtained from other farms: standard N,P values expressed per kg or per ha of crop (supp. table 9)
- Origin N,P values for ingredients: analysed and documented by the feed supplier and standard values from feed stuff tables.

→ Use of actual amount and composition of feed !

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Supplementary table 9, feed materials

Gewas	Opbrengst (ton ds/ha)	Opbrengst (ton product/ha)	Stikstofgehalte (kg stikstof/ ton ds)	Fosfaatgehalte (kg fosfaat/ ton ds)	Stikstofgehalte (kg stikstof/ton vers product)	Fosfaatgehalte (kg fosfaat/ton vers product)
Snijmais	15,9	44,2	11,5	4,4	4,1	1,6
Maiskolvenschroot	7,8	14,0	14,4	5,7	7,6	3,0
Corncobmix (100% spil)	7,5	14,6	15,7	6,2	8,0	3,2
Corncobmix (25% spil)	7,5	12,8	15,5	7,3	9,1	4,3
Korrelmais	7,9	9,1	13,1	5,5	11,4	4,8
Gehele plant silage	8,8	10,5	16,2	6,9	6,0	2,6
Tarwe	7,0	8,1	17,8	6,9	15,4	6,0
Erwten	5,5	6,5	33,8	9,2	29,3	7,9
Gerst	5,5	6,3	16,6	7,6	14,5	6,6
Aardappelen (vers)	10,0	50,7	16,3	5,7	3,2	1,1
Aardappelen (kuil)	_1	_1	15,7	4,6	5,5	1,6
Appelen	_1	_1	4,2	1,8	0,7	0,3
Graanstro (rogge)	3,6	4,3	4,6	2,3	3,9	1,9
Graanstro (tarwe)	3,5	4,1	7,0	2,5	6,4	2,3
Grashooi	_1	_1	21,1	6,2	17,8	5,2
Graskuil	_1	_1	27,0	9,0	12,4	4,1
Graszaadstro	_1	_1	11,2	3,9	9,5	3,3
Rogge	3,5	4,0	15,7	7,3	13,7	6,4
Uien	5,6	56,4	21,6	7,1	2,2	0,7
Voederbieten	15,5	100,0	11,8	3,0	1,5	0,4
Witlofwortelen	_2	_2	9,3	4,6	1,4	0,7
Kaaswei			33,4	18,8	1,6	0,9

Retention of N,P in pigs

- Number and weight of animals produced
- Use of actual weight obligatory if known (e.g. slaughter)
- Standard values for N,P content per animal category (suppl. table 7)

→ use of actually realised pig production!

→ use of standard N,P content (updated for entire males), presumably not a major factor of variation

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Supplementary table 7, composition of pigs

Diersoorten Varken	Diercategorie-code	Per kg lichaams gewicht[1] Kg stikstof	Kg fosfaat
Pasgeboren biggen	Va 1	0,0187	0,0141
Gespeende biggen, ongeveer 6 weken oud	Va 2	0,0244	0,0122
Biggen van ongeveer 10 weken (ca. 25 kg)	Va 3	0,0248	0,0122
Vleesvarkens	Va 4	0,0250	0,0123
Fokzeugen	Va 5	0,0250	0,0123
Opfokzeugen/beren van ongeveer 7 maanden	Va 6	0,0249	0,0132
Fokberen ouder dan 7 maanden	Va 7	0,0250	0,0123
Slachtzeugen	Va 8	0,0250	0,0123

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Background of N,P in pig bodies

- Scientific literature and national studies into whole body N,P content (carcass grinding)
- General update Jongbloed et al. (2002, 2005)
- Little information on cull sows, extrapolated from GF pigs.
- Evaluation when new information comes available or on request of stakeholders (e.g. farmers)
- Most recent evaluation based on Bikker et al. (2013)
- New data are added to database rather than just replacing earlier information.

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P in pig bodies at 25 and 125 kg LW

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25 kg: 5.27±0.37, present forfait: 5.33 g P/kg LW

125 kg

	P, % of CVB standards							P-value	
	50	70	90	110	130	mean	SE	P-cont.	Sex
Mean	3.88[a]	4.10[a]	4.79[b]	5.22[c]	5.58[c]	4.71	0.13	<0.001	0.015
Boars	3.64	3.82	4.53	5.22	5.62	4.57	0.08		
Sows	4.13	4.38	5.05	5.21	5.54	4.86	0.08		

Present forfait: 5.37 g/kg
No difference between gilts and boars at adequate diet P
Actual P-content depends on P-supply

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Results, N in pigs at 25 and 125 kg

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25 kg
Bikker et al (2013): 25.6±1.0 g N/kg,
present forfait: 24.8 g N/kg

125 kg
Bikker et al (2013): 25.9±2.5 g N/kg,
present forfait: 25.0 g N/kg

Entire males pigs 26.4 g N/kg
Female pigs 25.5 g N/kg

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Production of animal manure (pigs)

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	Correction gaseous N losses
Sum input	Sum output
Manure production = sum input – output	

Gaseous N emissions

Expressed in kg/animal/year

In 4 categories:

- Solid or liquid manure
- "Normal" or low emission barn (e.g. air scrubber)

For sows, piglets, growing-finishing pigs and rearing pigs

→ Fixed correction for N emission based on type of housing

Supplementary table 4, gaseous losses

Diersoort en -categorie [1]	Dier-categorie nummer	Graasdier / Staldier	Stalsysteem	Excretie per dier in de periode van 1 aug tot 1 maart m^3 [2]	Excretie per dier per jaar kg stikstof [3]	Excretie per dier per jaar kg fosfaat [4]	Stikstof-correctie kg/dier/jaar [5]
Varken	40						
Fokzeugen waarvan de gespeende biggen op een ander bedrijf worden gehouden (ten minste eenmaal gedekte of geïnsemineerde zeugen, guste zeugen, gedekte maar nog niet drachtige zeugen, drachtige zeugen, zeugen met biggen, zeugen waarvan de biggen gespeend zijn en waarvan de gespeende biggen aan een ander bedrijf worden geleverd).	400	S	Vaste mest, emissie-arm	1,03	19,6	-	2,1
			Vaste mest, overig	1,03	17,9	-	3,8
			Drijfmest, emissie-arm	1,4	19,7	-	2,0
			Drijfmest, overig	1,4	17,2	-	4,5

Gaseous N-losses (in kg/animal/year)

	emission	N-excr.	Losses of N	Losses of N, %	N in manure
Sows	low	21.7	2.0	9.2	19.7
	normal	21.7	4.5	20.7	17.2
Sows + piglets	low	30.3	2.8	9.2	27.5
	normal	30.3	6.2	20.5	24.1
Piglets	low	3.9	0.4	10.3	3.5
	normal	3.9	0.8	20.5	3.1
GF pigs	low	12.4	1.8	14.5	10.6
	normal	12.4	3.5	28.2	8.9

Production of animal manure (pigs)

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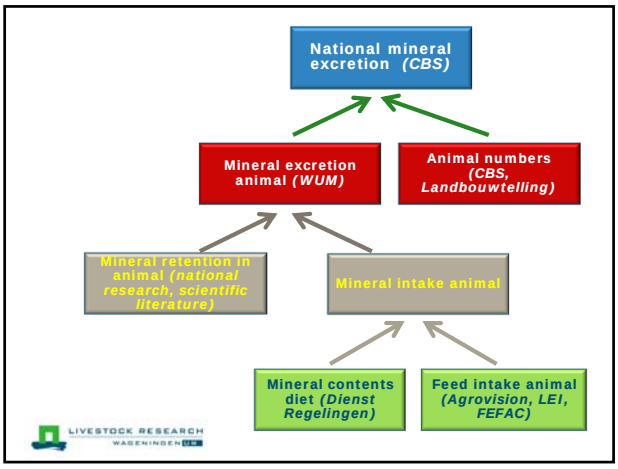
→ Registered manure transport; applied within legal limits

Summary of administration (simplified)

- Animal numbers and transport to/from farm
- Ha grassland and arable land
- Type of crops (ha, location)
- Transport of manure, plus analysed composition (N,P)
- Use of fertiliser
- Transport and use animal feed plus composition (N,P)
- Production and use home grown feed
- Once a year: stock of feed, animals, manure, etc.

- Own administration plus (partly) to NL authorities



Mean N,P excretion in NL 2013 (CBS data)

Per year	GF pig (25-118 kg)	Sows + piglets
Production	795 g/d	28.4 piglets of 24.9 kg
Feed, kg	146 grower	804 piglet feed
	602 finisher	1179 sow feed
Mean feed composition		
CP, g/kg	161	158
P, g/kg	4.5	5.3
Intake, kg N,P	19.3 / 3.4	49.9 / 10.4
Retention	7.3 / 1.6	18.8 / 4.0
Excretion	12.0 / 1.8	31.1 / 6.4
Efficiency, %	38 / 47	38 / 38

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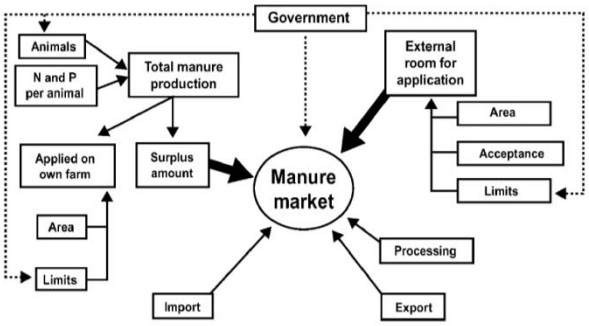
Some consequences of the system

- Direct restriction of application of manure (N,P) to crops
- Direct relation between manure production and cropland → excess need to processed or exported
- High cost of manure handling for all pig farmers (M^3, P)
- Competitive effect of other species, mainly cattle
- Stimulation of reduction of N, P excretion?
  - ++ for pig farms with cropland
  - +/- for intensive pig farms
  - + for the total of pig farmers

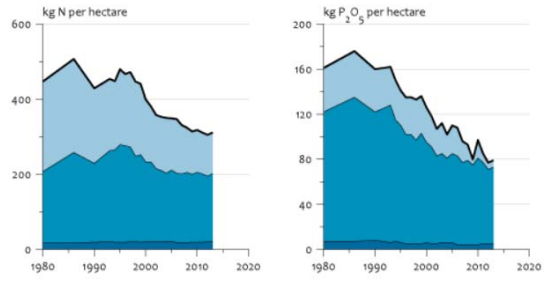
Scheme of manure market (Oenema, 2004)



Contribution of scientific developments

- Insight in amino acids (AA) and P requirements of growing pigs and sows
- Insight in digestibility of AA and P of feed ingredients (e.g. on standardised digestible basis)
- Development of models for digestion and retention of nutrients (e.g. calcium – P interaction)
- Improvement of nutrient digestibility (e.g. phytase)
- Molecular mechanisms of absorption and retention of nutrients
- Processing and re-utilisation of nutrients excreted in manure
- Major steps have been made, smaller steps expected

Development in application of N and P/ha



Fertiliser
Animal manure
Other input

source: CBS

Other environmental aspects of pig feed

- Contribution of pig manure to accumulation of Zn and Cu in the soil.
  - Over 90% of inclusion in feed is excreted in manure
  - Debate at EU level to reduce max. inclusion level
  - Use of high ZnO in weaning pigs
- Carbon footprint of pig production
  - Largely related to feed production
  - At present being documented; driver in the future?
- Competition between feed and food (and non-food)
  - Decrease in the use of human edible crops for feed

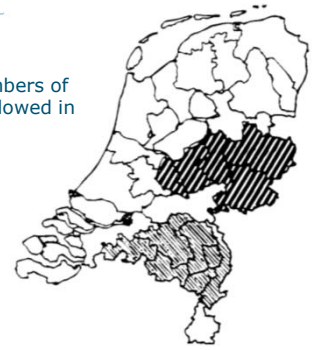
Summary of relevant legislation

- Number of pigs maximised by "production rights"
- Maximum application of manure and fertilisers to grassland and cropland
- Reduction of ammonia emission by technical measures
- Processing of manure is obligatory for farms with manure surplus, depending on area within NL: 10-55% of surplus.
- Sufficient and adequate manure storage
- No spreading of manure during winter, etc.

The Netherlands: animal dense areas

(concentratiegebieden varkens en pluimveerechten)

No increase in numbers of pigs and poultry allowed in these areas



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Summary and conclusions

- The manure legislation is based on max. application of manure on grass- and cropland.
- Farmers need to document manure production and use.
- Excretion of N,P is based on actual feed intake and composition, actual performance (gain, piglets) and standard body N,P content
- Market conditions determine the benefit of further reduction of N,P excretion per animal
- Related legislation (pig production rights, ammonia emission, manure processing) plays an important role.
- Future: balance between N,P production in manure and use on cropland plus required export from the NL

Thank you for your kind attention

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paul.bikker@wur.nl