Risks of livestock manure application

October 24th, Bjorn Berendsen

WAGENINGEN
UNIVERSITY & RESEARCH

100years
1918 — 2018

Project team

- PSG-WPR: Leo van Overbeek
- ESG-WEnR: Joost Lahr, Jaap van Os, Louise Wipfler
- ASG-WBVR: Dik Mevius, Ales Bossers
- ASG – WLR: Paul Hoeksma
- AFSG-Food Micro: Tjakko Abee, Marcel Zwietering
- SSG-WEcR: Nico Bondt, Ron Bergevoet, Tanja de Koeijer
- WFSR: Bjorn Berendsen

Global One Health approach

Dissipation routes via manure

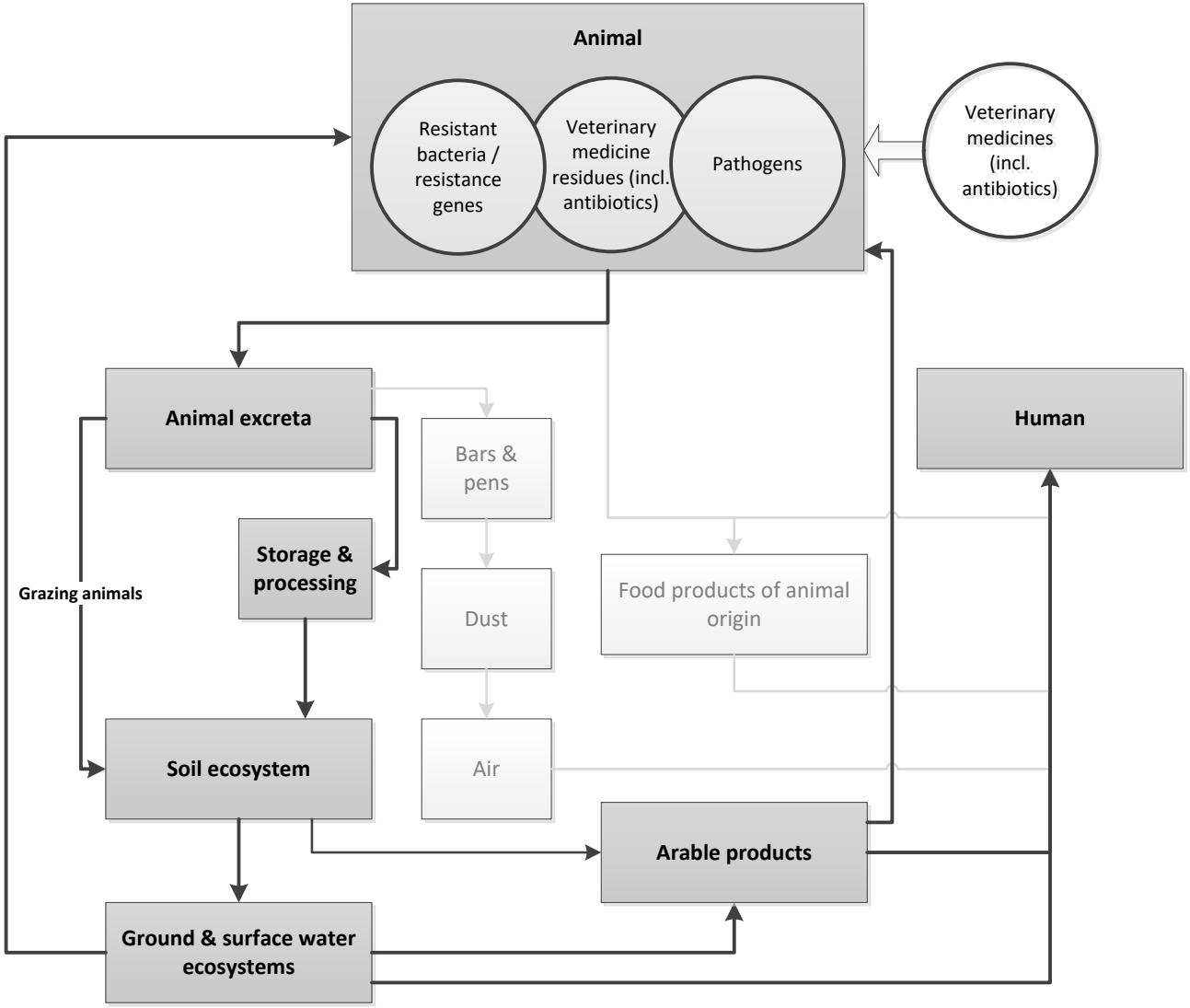

Figure 1. Routes for the spread of manure constituents. The route through animal excreta is highlighted.

Risks of livestock manure application

- Goals:
  - Selection of the most relevant antibiotics and pathogens
  - Optimisation of the analytical methods for antibiotic analysis
  - Study the fate of antibiotics and pathogens
  - Model manure distribution and antibiotic load
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  - Study circulation of pathogens and antibiotics in the ecosystem

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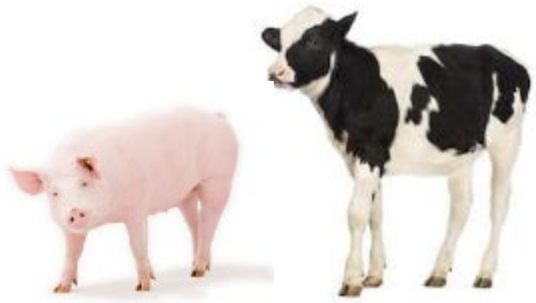
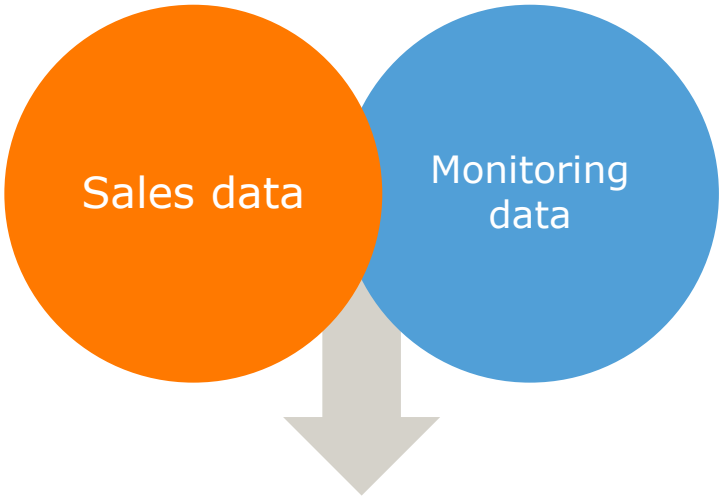
Selection of most relevant antibiotics





10 prioritized antibiotics


8 WATER MATTERS

AUTEURS

AANZET TOT MILIEUPRIORITERING VAN DIERGENEESMIDDELEN UIT DIERLIJKE MEST

In Nederland wordt dierlijke mest uit de intensieve veehouderij op grote schaal uitgereden op akkers en grasland. Deze mest kan resten bevatten van diergeneesmiddelen die aan landbouwhuisdieren zijn gegeven. Sommige van deze stoffen worden steeds vaker in grondwater en oppervlaktewater gevonden. Beleidsmakers en bodem- en waterbeheerders willen daarom graag meer inzicht in de waarschijnlijkheid dat diergeneesmiddelen in het milieu terecht komen.

H2O

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100years

Selection of most relevant pathogens

- Expert meeting:
  - Wageningen UR
  - GD
  - RIVM
  - enkele
  - Ministeries
  - Provincies
  - Waterschappen

Pathogenen in dierlijke mest: riskant?

Door aanscherping van mestgebruiksnormen worden transport en verwerking van dierlijke mest in Nederland steeds noodzakelijker. Dat leidt tot een afname van de milieubelasting door mineralen in de mest, maar wat betekent het voor de veiligheid? Bij de Q-koortsepidemie kon een verband worden gezien met het uitrijden van mest van besmette bedrijven. Bestaat dit risico nog steeds en hoe zit het eigenlijk met andere ziekteverwekkers? Uit een verkennende brainstorm met deskundigen blijkt dat we momenteel niet gecon-fronteerd worden met grote risico's. Wel zijn er punten naar voren gekomen die de aandacht verdienen om deze risico's beperkt te houden.

Pathogens and antibiotics in the chain

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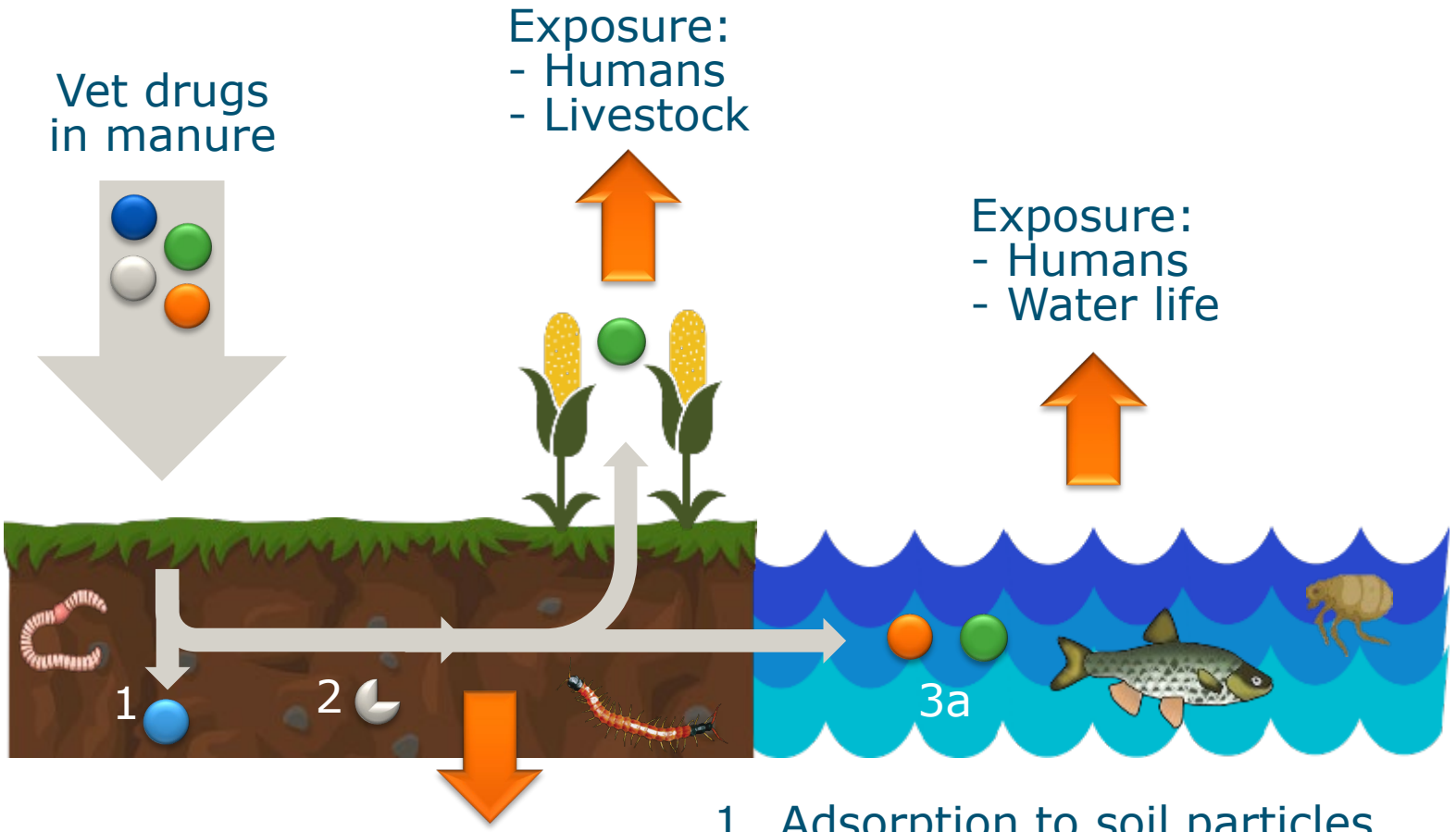
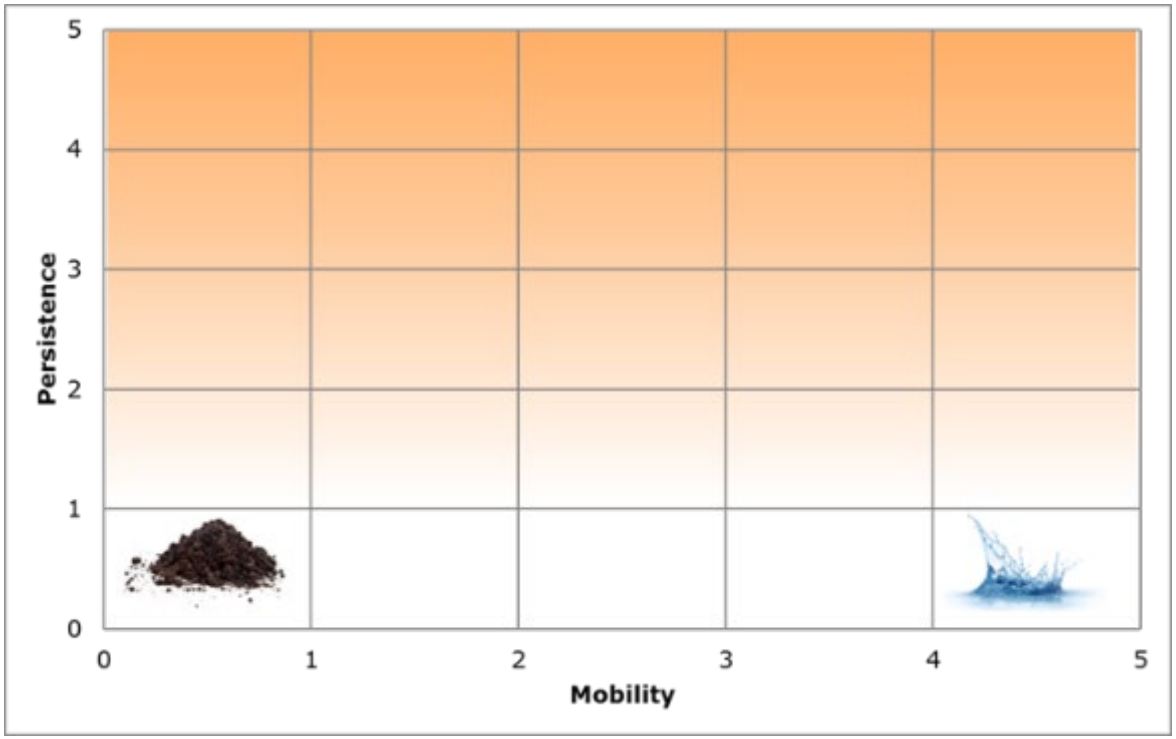
The fate of antibiotics



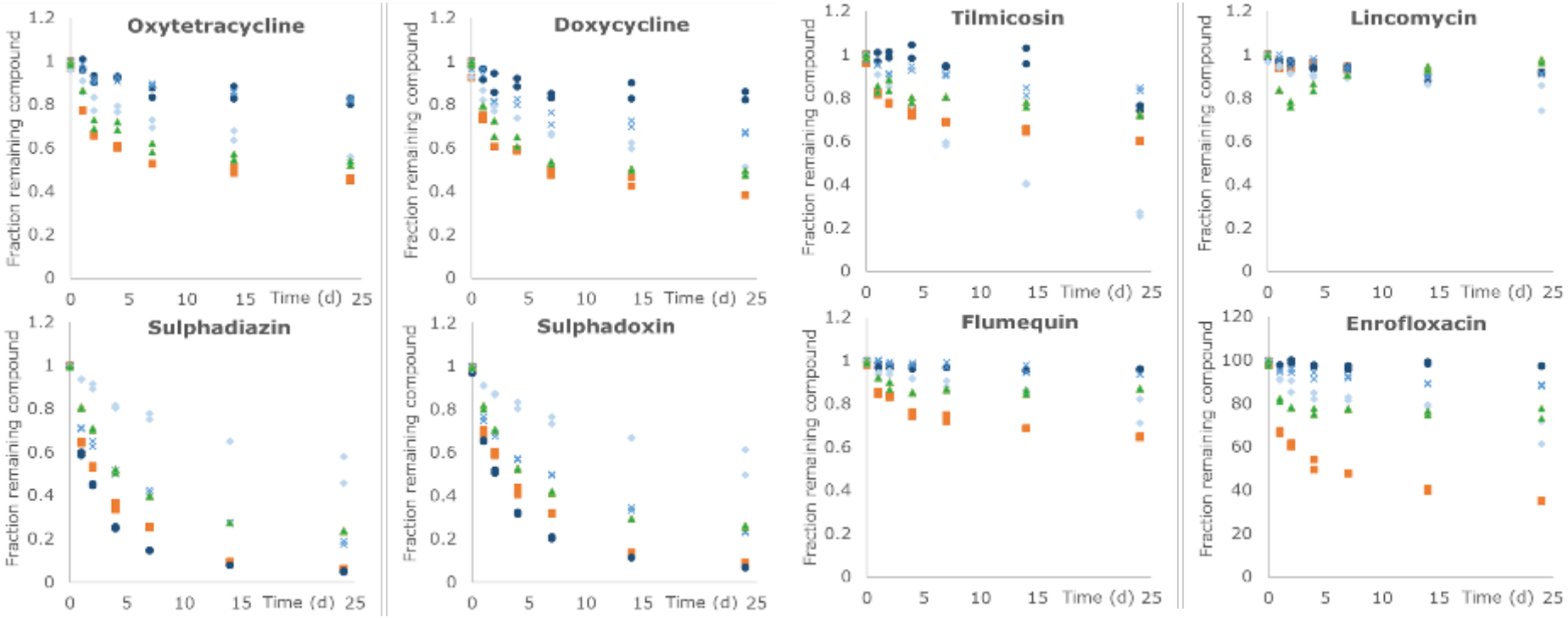
1. Adsorption to soil particles
2. Degradation / inactivation
3. Leaching
   a. To surface water
   b. Uptake by crops

The fate of antibiotics

- Persistence = ‘the continued or prolonged existence’
- Mobility = ‘the ability to move among reservoirs’



The fate of antibiotics - persistence



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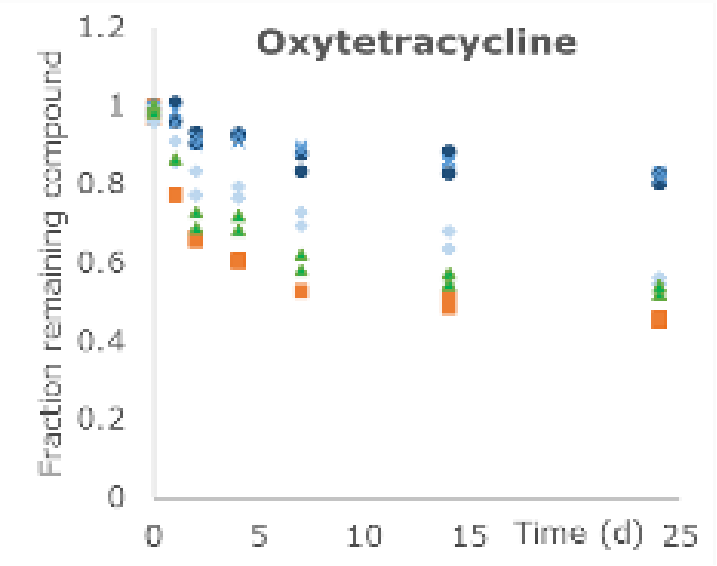
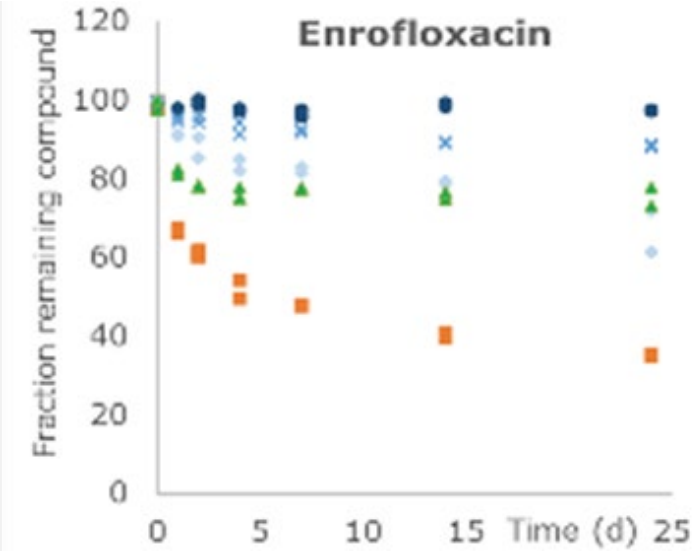
The fate of antibiotics - persistence

- Diphasic degradation observed for especially tetracyclines and quinolones. Binding to organic particles might contribute to their persistence.





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The fate of antibiotics - persistence

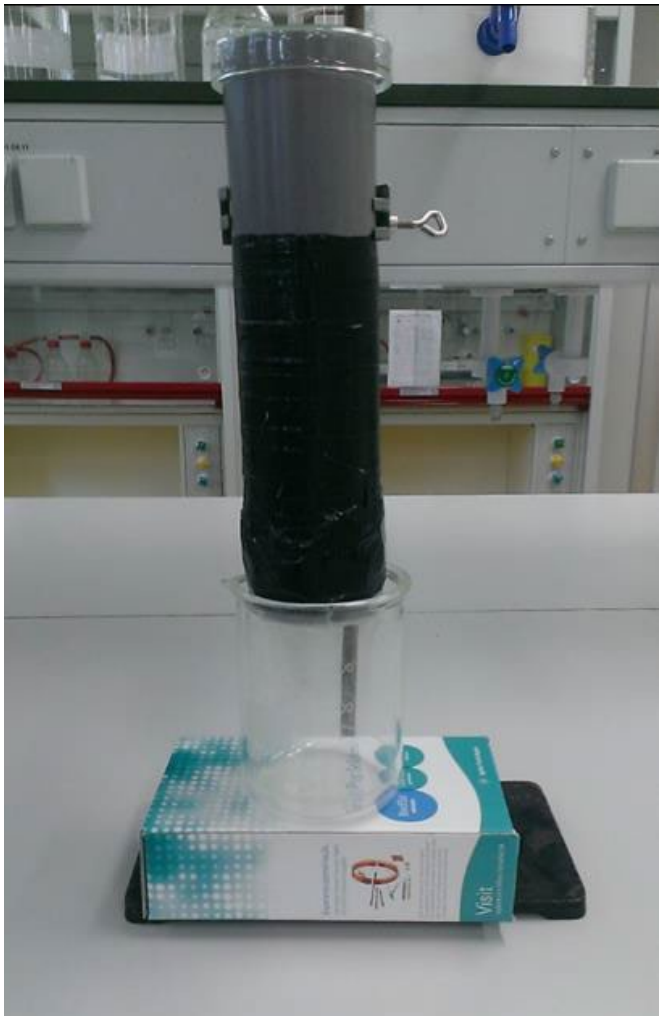
Compound group	Very persistent DT90 > 1 y	Persistent DT90 > 6 m	Moderately persistent DT90 > 3m	Slightly persistent DT90 > 1 m	Non-persistent DT90 ≤ m
Tetracyclines		x			
Sulphonamides			x	x	x
Quinolones	x	x			
Macrolides		x	x		
Lincosamides	x				
Pleuromutilins	x		x		

The fate of antibiotics - persistence

- Persistence in manure depends mainly on animal species.
- The tested antibiotics, with exception of the sulphonamides are moderately to very persistent.
- Even after 9 months storage, some antibiotics can persist in manure and can be transferred to agricultural soils.
- Based on the persistence and frequency of use, currently, environmental exposure to oxytetracycline, doxycycline, flumequine, tilmicosin and lincomycin seems most likely.

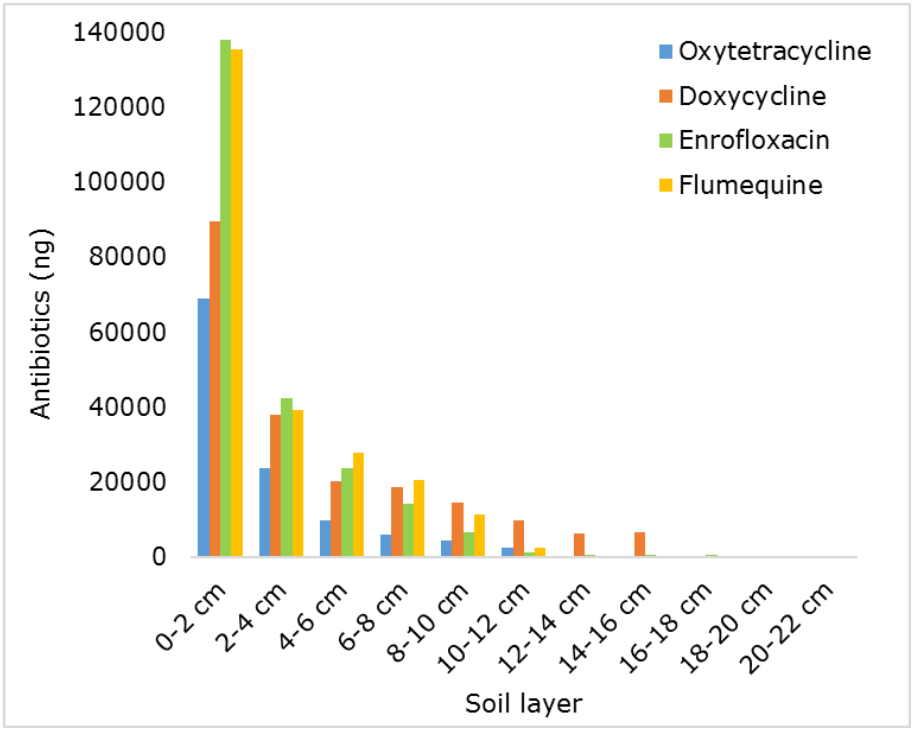
The fate of antibiotics - mobility

- Soil column experiment
  - Packed with wetted soil
  - 300 µg of the antibiotics applied
  - 50 ml water daily
  - Isolate eluate daily
  - Isolate 2 cm soil layers after 15 days

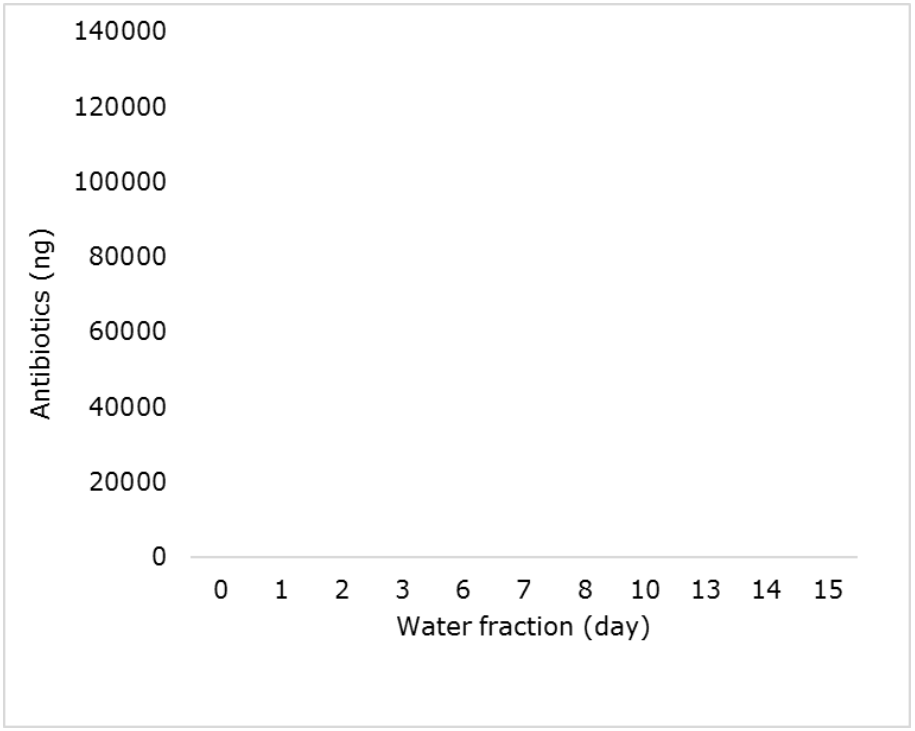


The fate of antibiotics - mobility

Soil layers



Water fractions



The fate of antibiotics - mobility

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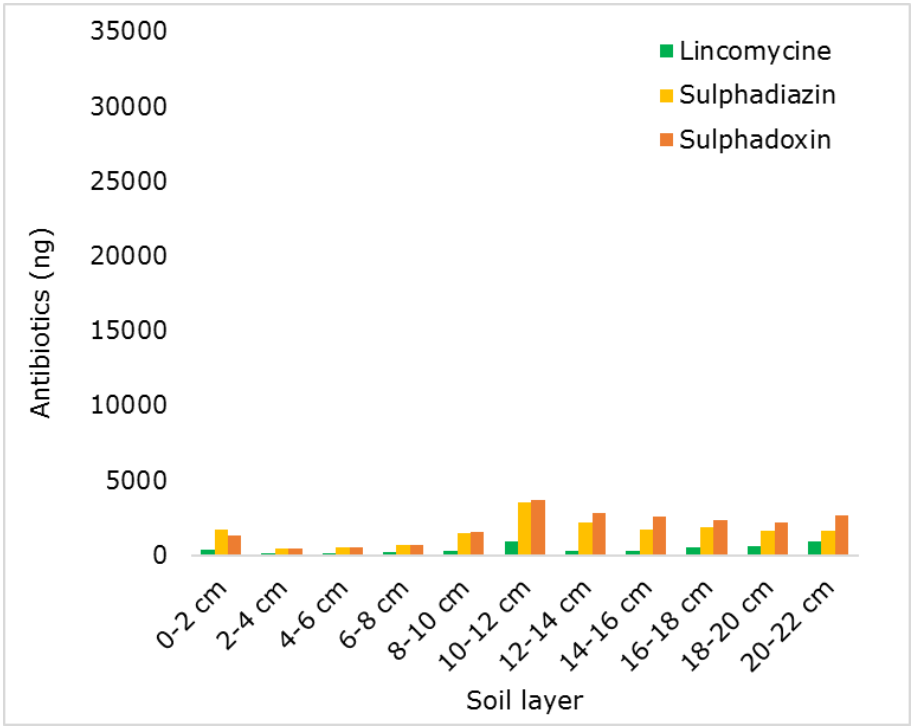

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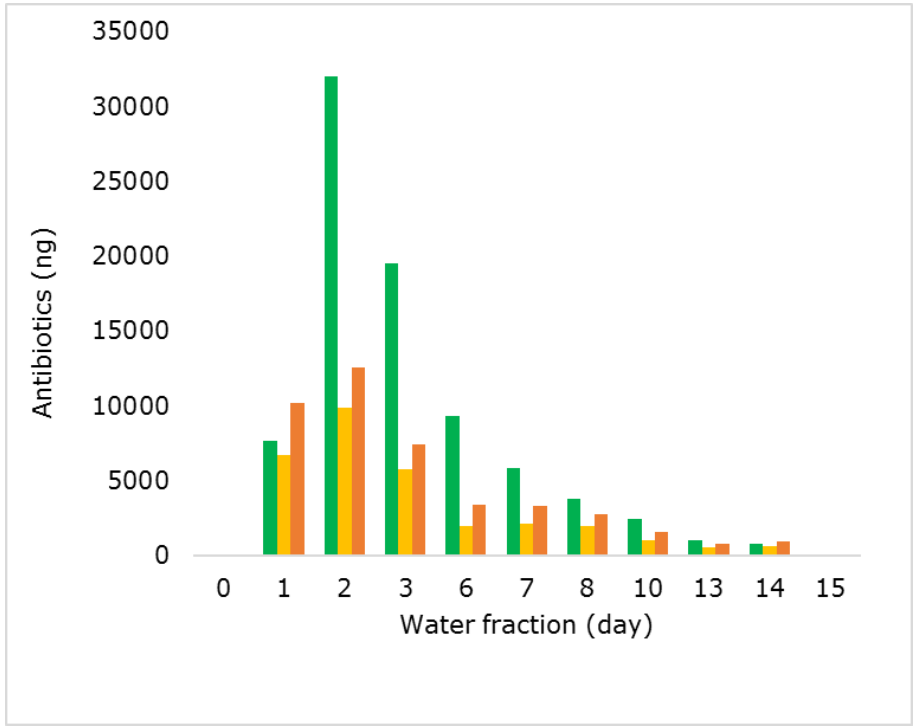
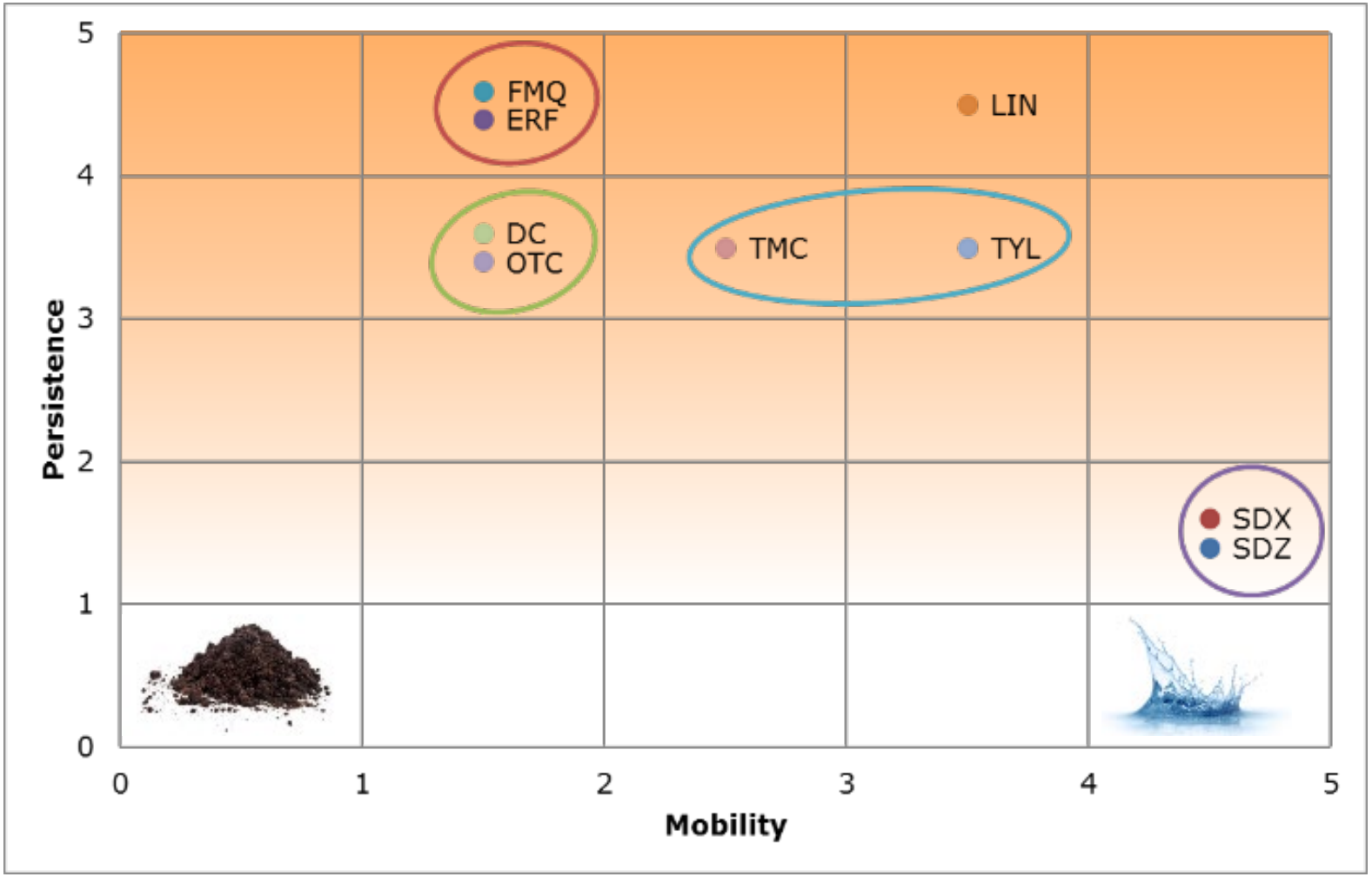


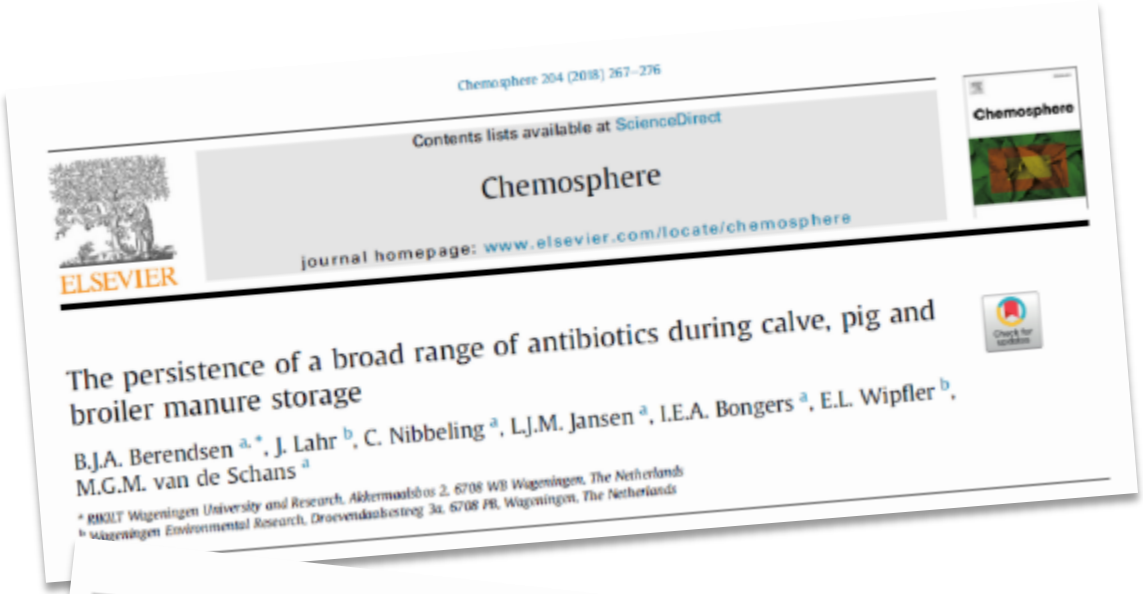
The fate of antibiotics



The fate of antibiotics


WATER MATTERS

AANZET TOT MILIEUPRIORITERING VAN DIERGENEESMIDDELEN UIT DIERLIJKE MEST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ELSEVIER

The persistence of a broad range of antibiotics during calve, pig and broiler manure storage

B.J.A. Berendsen [a, *], J. Lahr [b], C. Nibbeling [a], L.J.M. Jansen [a], I.E.A. Bongers [a], E.L. Wipfler [b], M.G.M. van de Schans [a]

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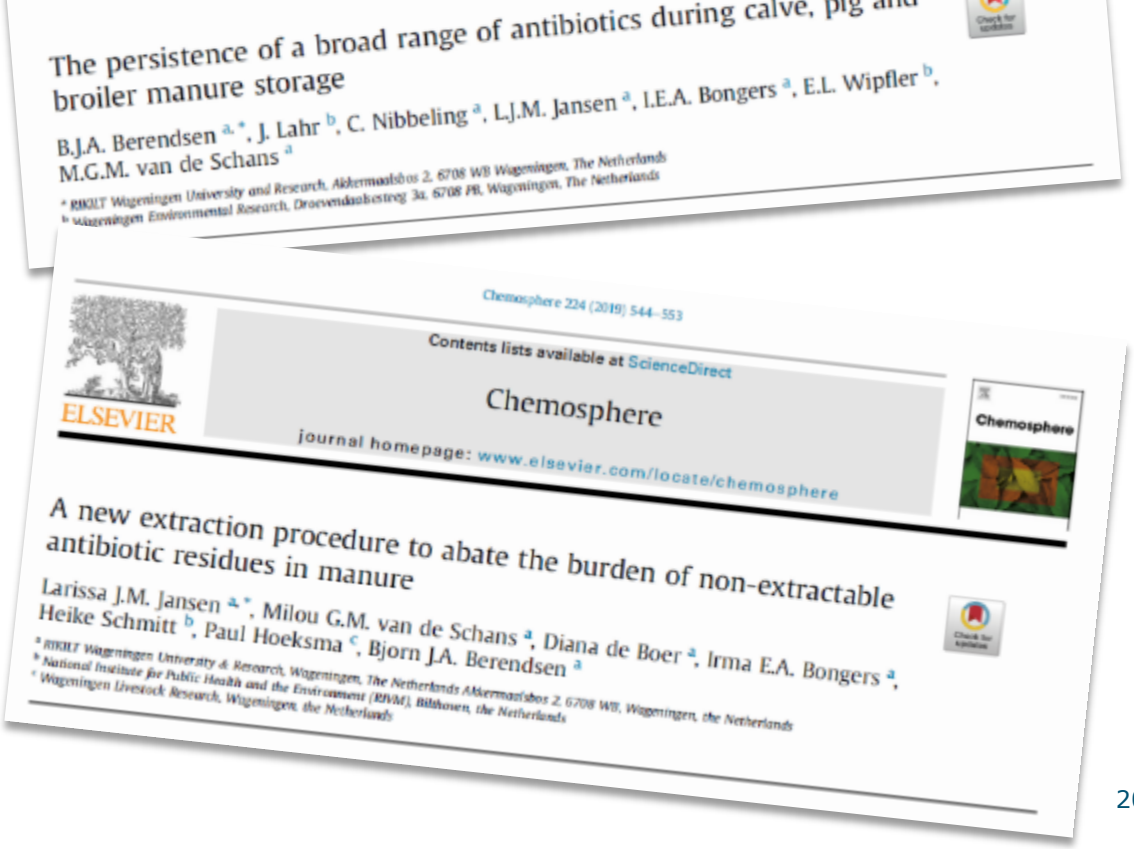
Chemosphere 224 (2019) 544–553

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ELSEVIER

A new extraction procedure to abate the burden of non-extractable antibiotic residues in manure

Larissa J.M. Jansen [a, *], Milou G.M. van de Schans [a], Diana de Boer [a], Irma E.A. Bongers [a], Heike Schmitt [b], Paul Hoeksma [c], Bjorn J.A. Berendsen [a]

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Pathogens and antibiotics in the chain

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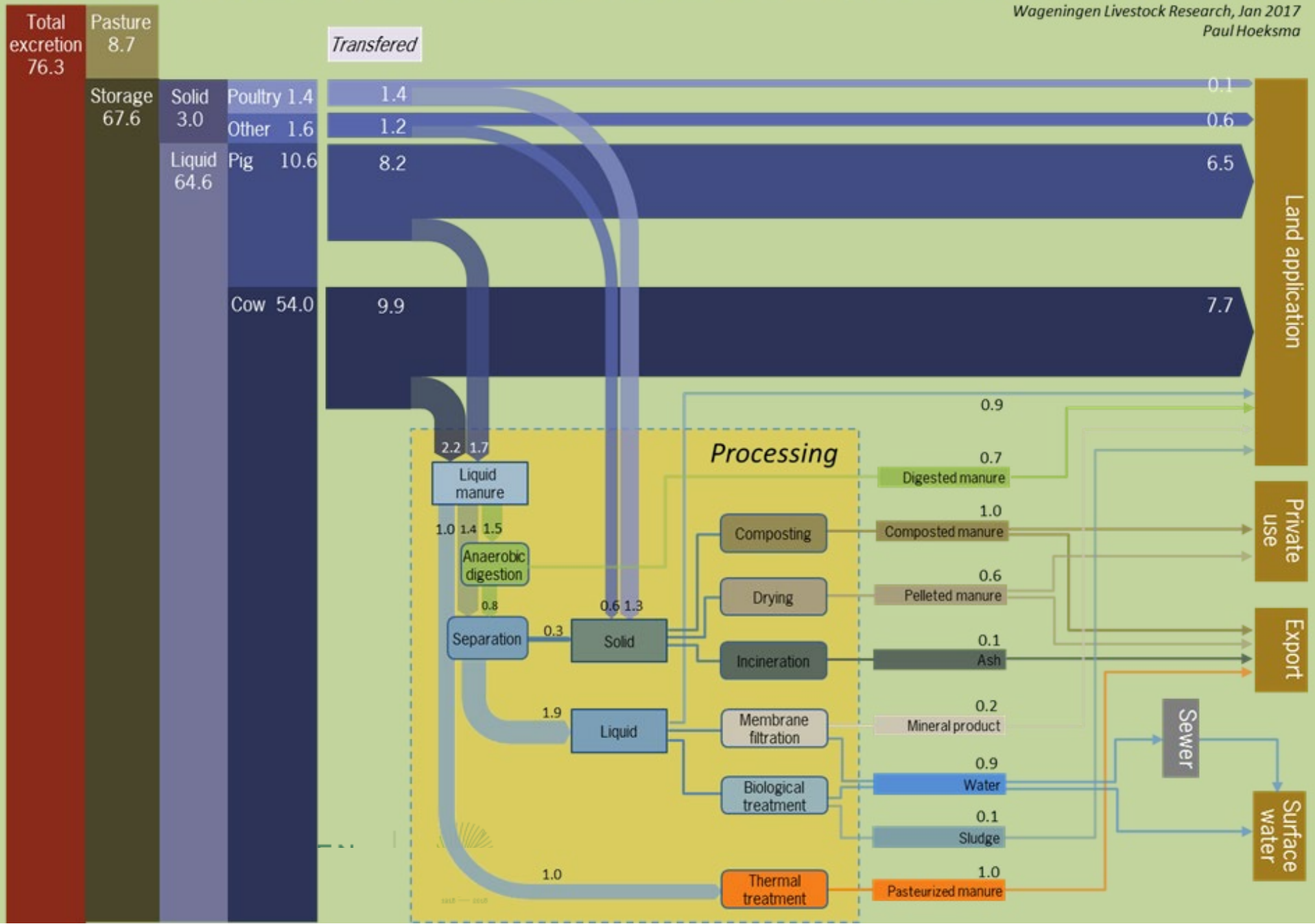
Livestock manure NL – excretion, transfer and processing (Mton/year)

Wageningen Livestock Research, Jan 2017
Paul Hoeksma



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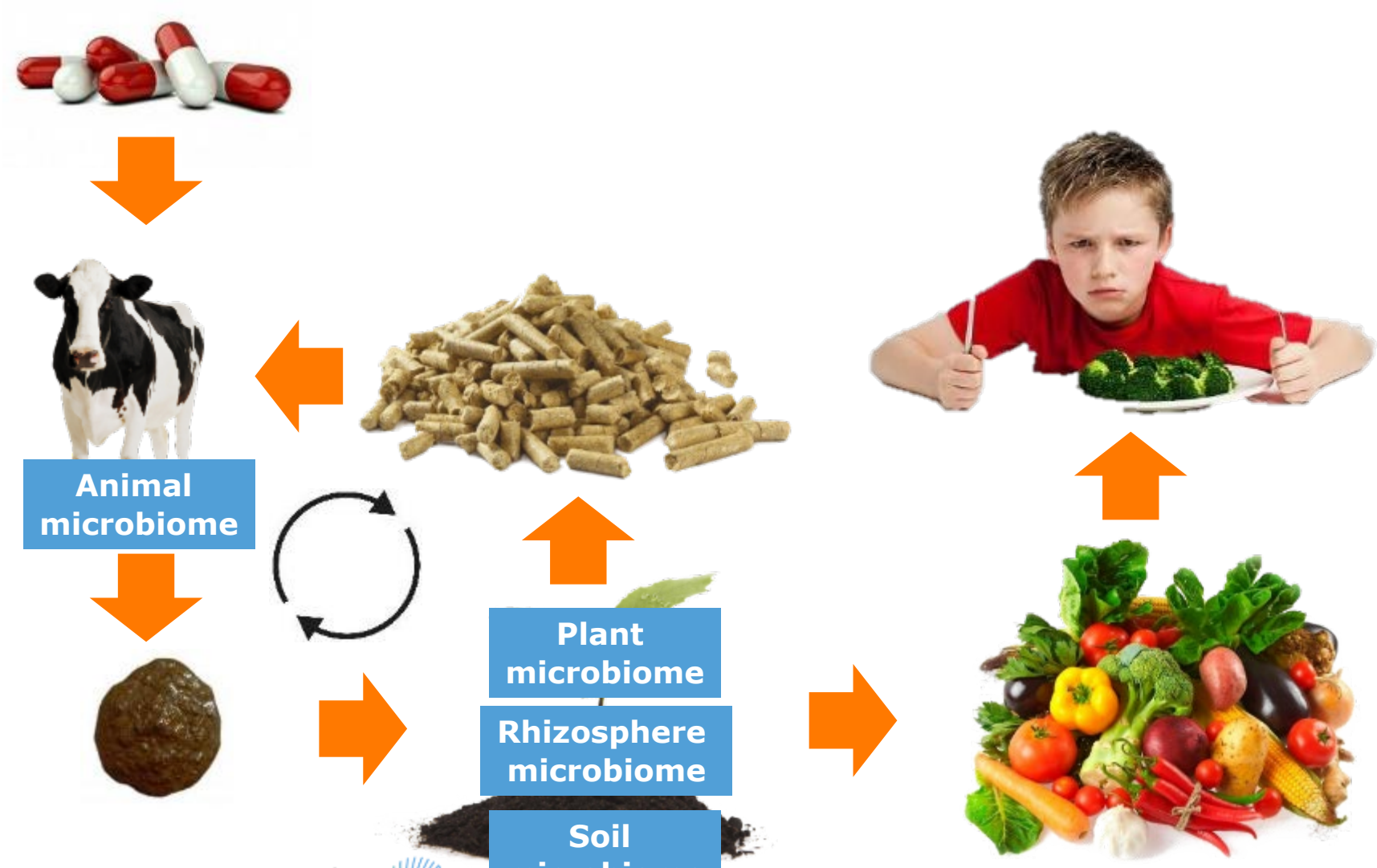
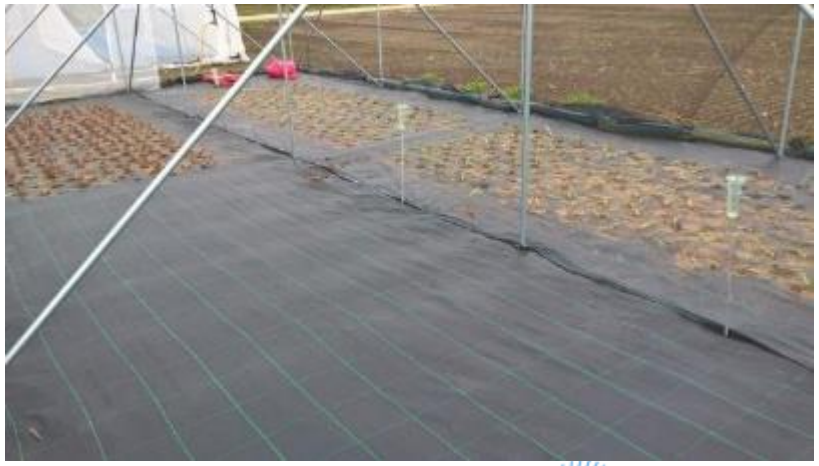
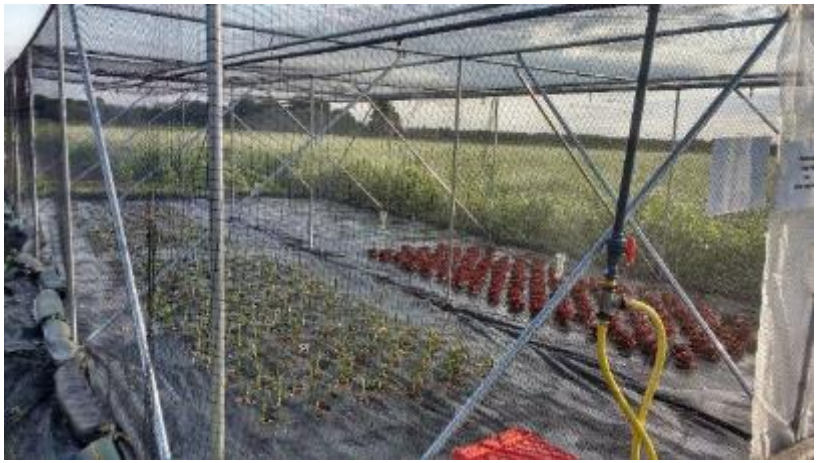


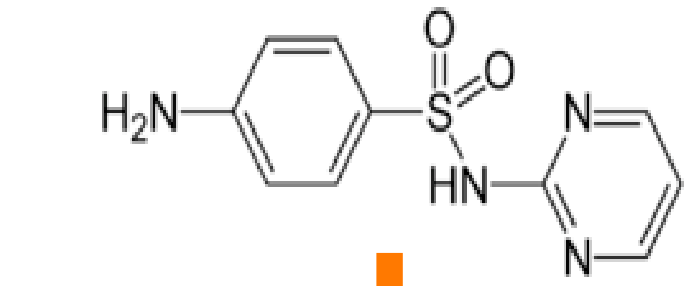




Circulation in the ecosystem

Sufadiazine (SDZ); mobile antibiotic



1 day
6 weeks

Circulation in the ecosystem

SDZ *in manured soil*:

Planting = 366 µg/kg

Harvest = 82.2 µg/kg

SDZ *in manured soil*:

Planting = 273 µg/kg

Harvest = 66.6 µg/kg

Circulation in the ecosystem

	Manure treatment		
	Untreated	-6 weeks	-1 day
	SDZ (ppb)	SDZ (ppb)	SDZ (ppb)
Rhizosphere	ND	0.47	0.47
Root	ND	ND	ND
Shoot	ND	0.07	0.08

Circulation in the ecosystem

	Manure treatment					
	Untreated		-6 weeks		-1 day	
	SDZ (ppb)	LogCFU/g soil	SDZ (ppb)	LogCFU/g soil	SDZ (ppb)	LogCFU/g soil
Rhizosphere	ND	5.79	0.47	6.58*	0.47	6.57*
Root	ND	4.63	ND	6.04*	ND	5.69*
Shoot	ND	4.10	0.07	3.78	0.08	3.65

* CFU values are significantly different (P<0.001) from non-fortified manure

Circulation in the ecosystem

- Sulfadiazine was taken up by lettuce and leek plants in low quantities.
- Higher SDZ-resistant bacterial numbers were found in the rhizosphere and roots of lettuce and leek

- *E. coli* was transmitted from manure to lettuce and leek plants and could persist in the leek rhizosphere during winter time.

Take home message

Take home message

- The risks of pathogens in manure for humans, animals and the environment is currently considerd to be low.
- Antibiotic residues occur in many reservoirs and we can now predict where the risk of occurrence of individual compounds is the highest.
- Antibiotic treatments cause alterations in the manure microbiome which is still observed in soil, rhizosphere and root after manure application.

- Interdisciplinary research involving different science groups yields new perspectives and high impact results.

Thank you!

WPR: Leo van Overbeek

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