



Is kringloopsluiting in de landbouw mogelijk met technologische ingrepen?

Prof. dr. ir. Cees Buisman

Dronten – 9 November 2023

Plants need more than CO₂ and H₂O

N	P	K	Mg
Ca	S	Fe	Mn
Zn	Ni	Cl	Mo
B		Cu	

14



23 Key nutrients for a healthy population

N	P	K	Mg
Ca	S	Fe	Mn
Zn	Ni	Cl	Mo
B	Cu	+	

Co	Na	Se	I
Cr	V	Sn	As
F			

14



23₍₁₄₊₉₎



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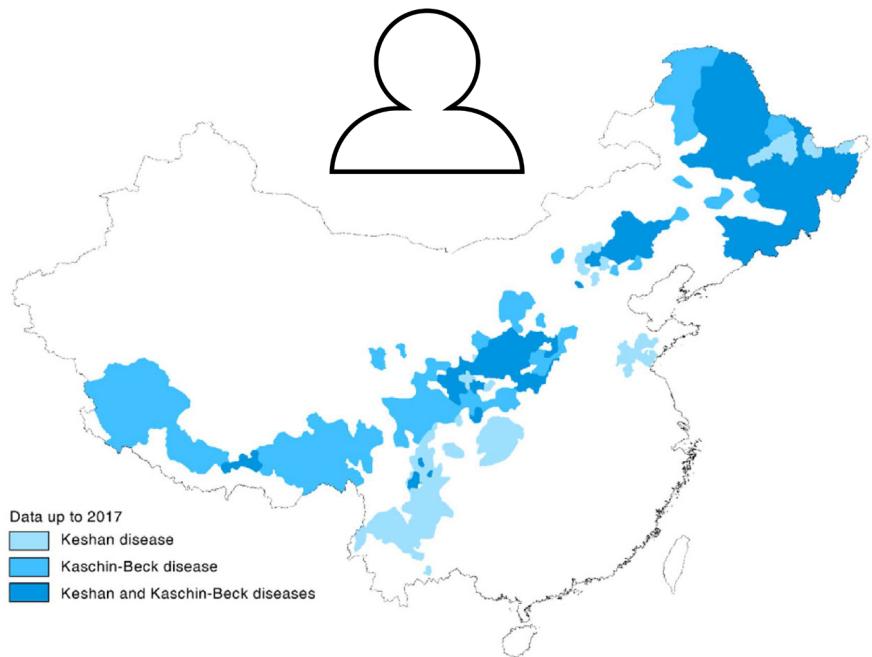
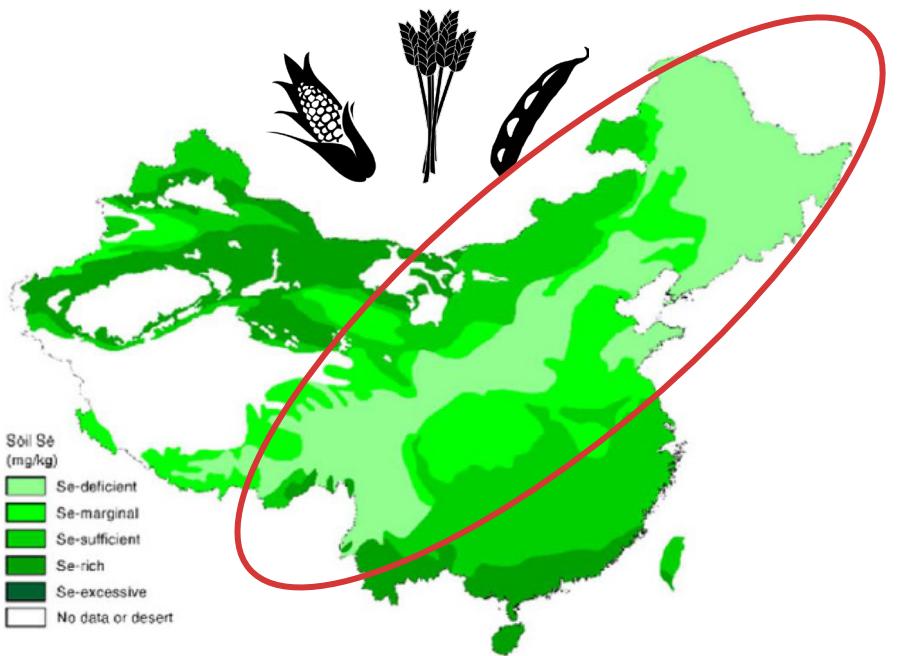
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23₍₁₄₊₉₎



Link between Se deficiency in soils and Se-related diseases in China



Source: Dinh *et al.* 2018

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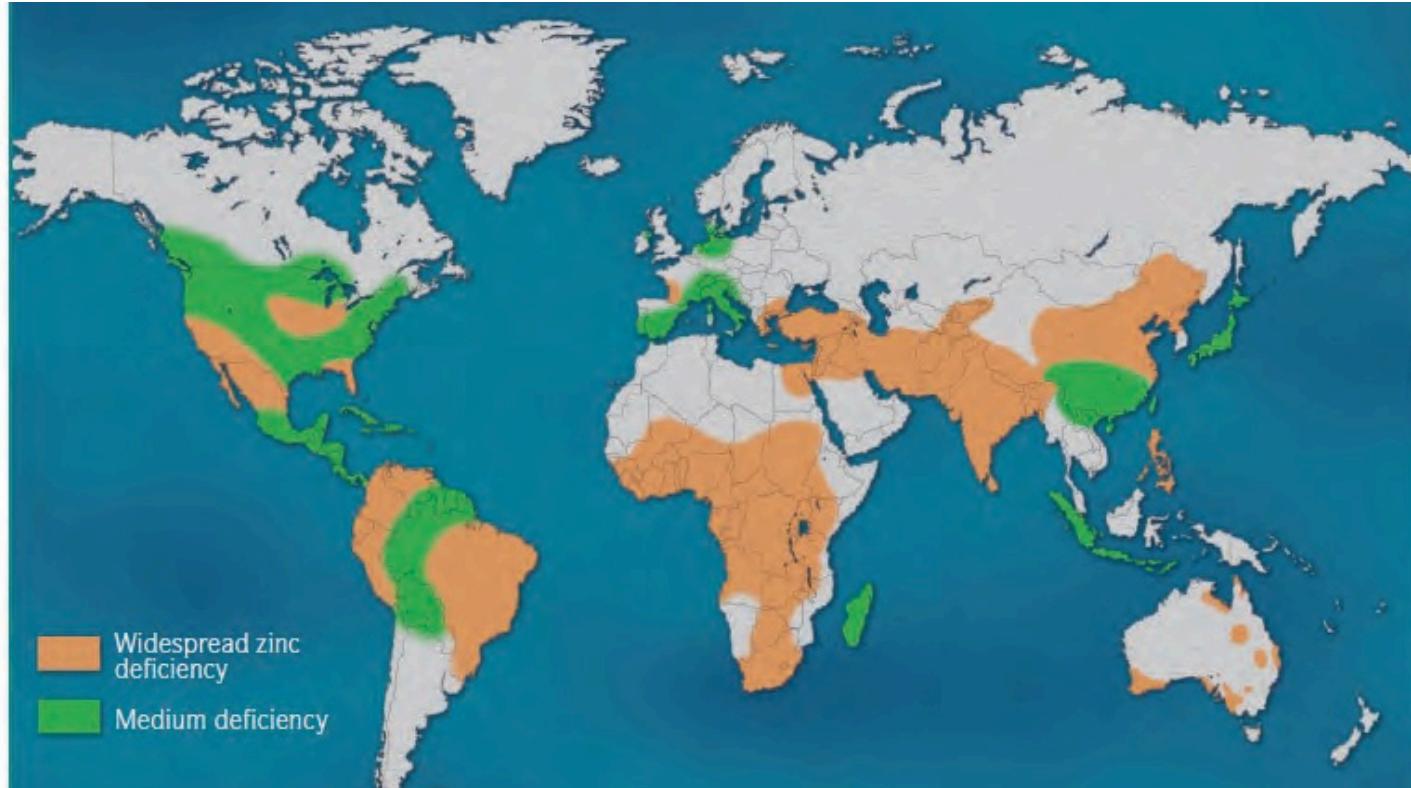
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Zinc deficiencies



Source: Alloway 2004

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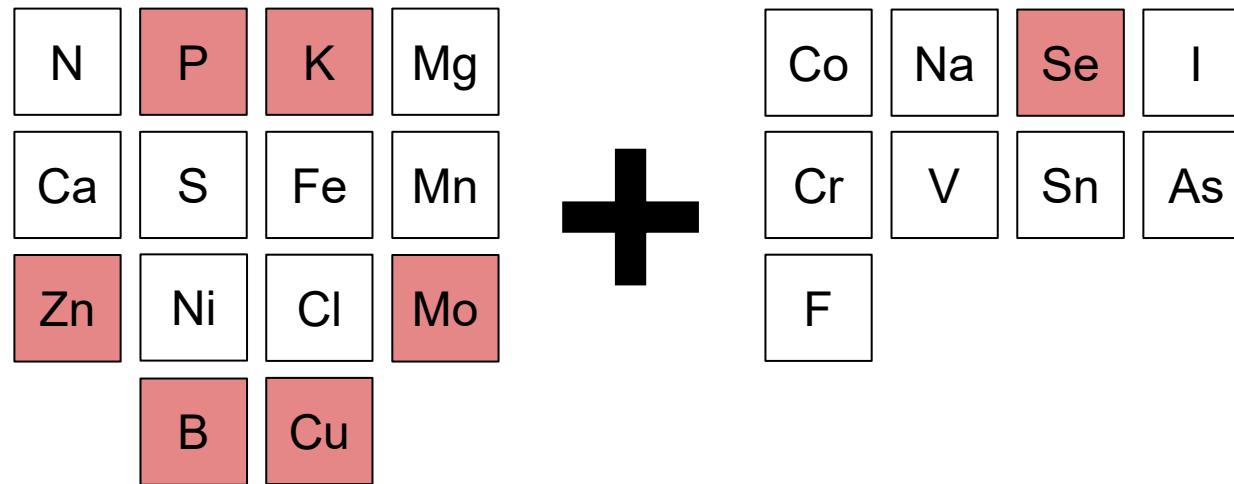
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Scarce elements



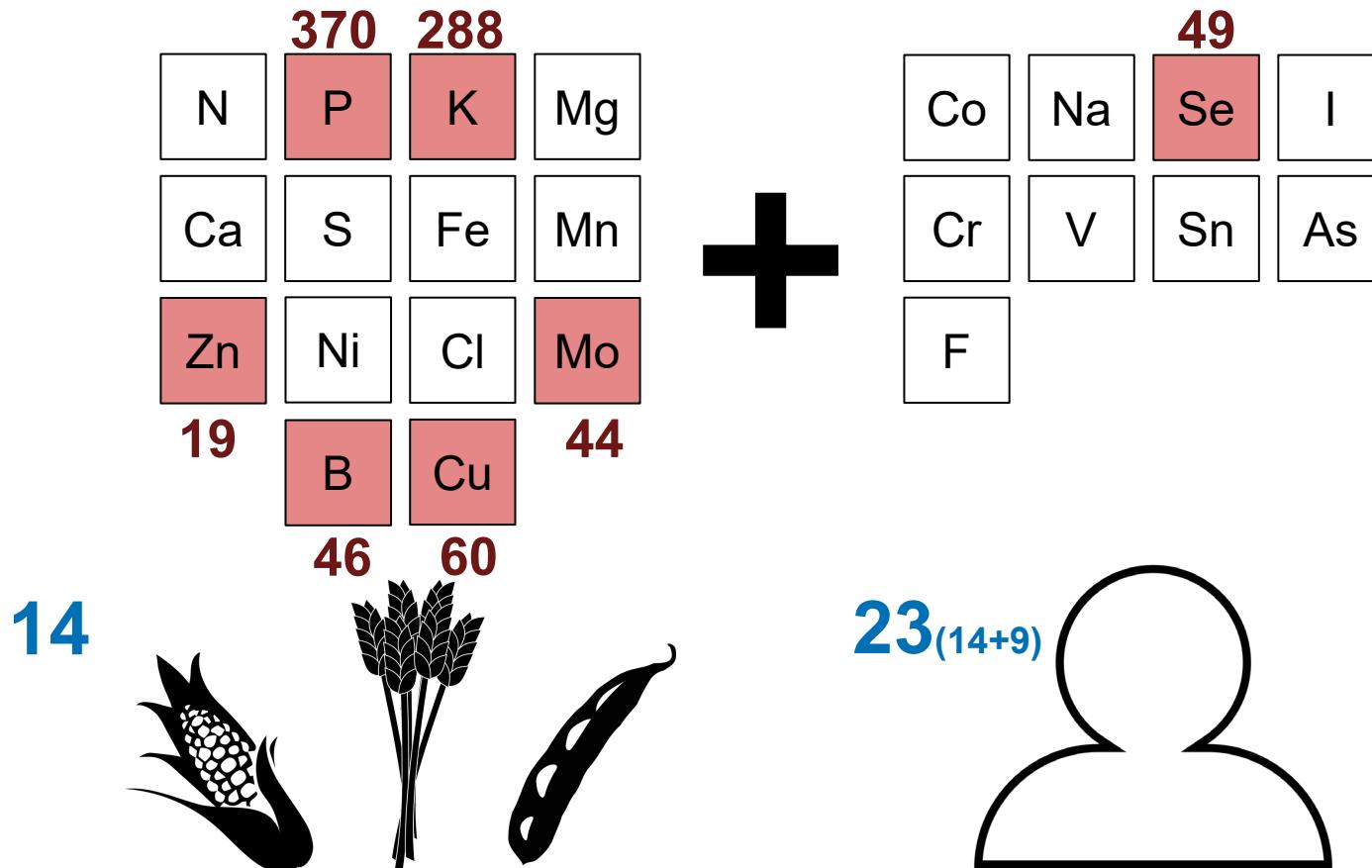
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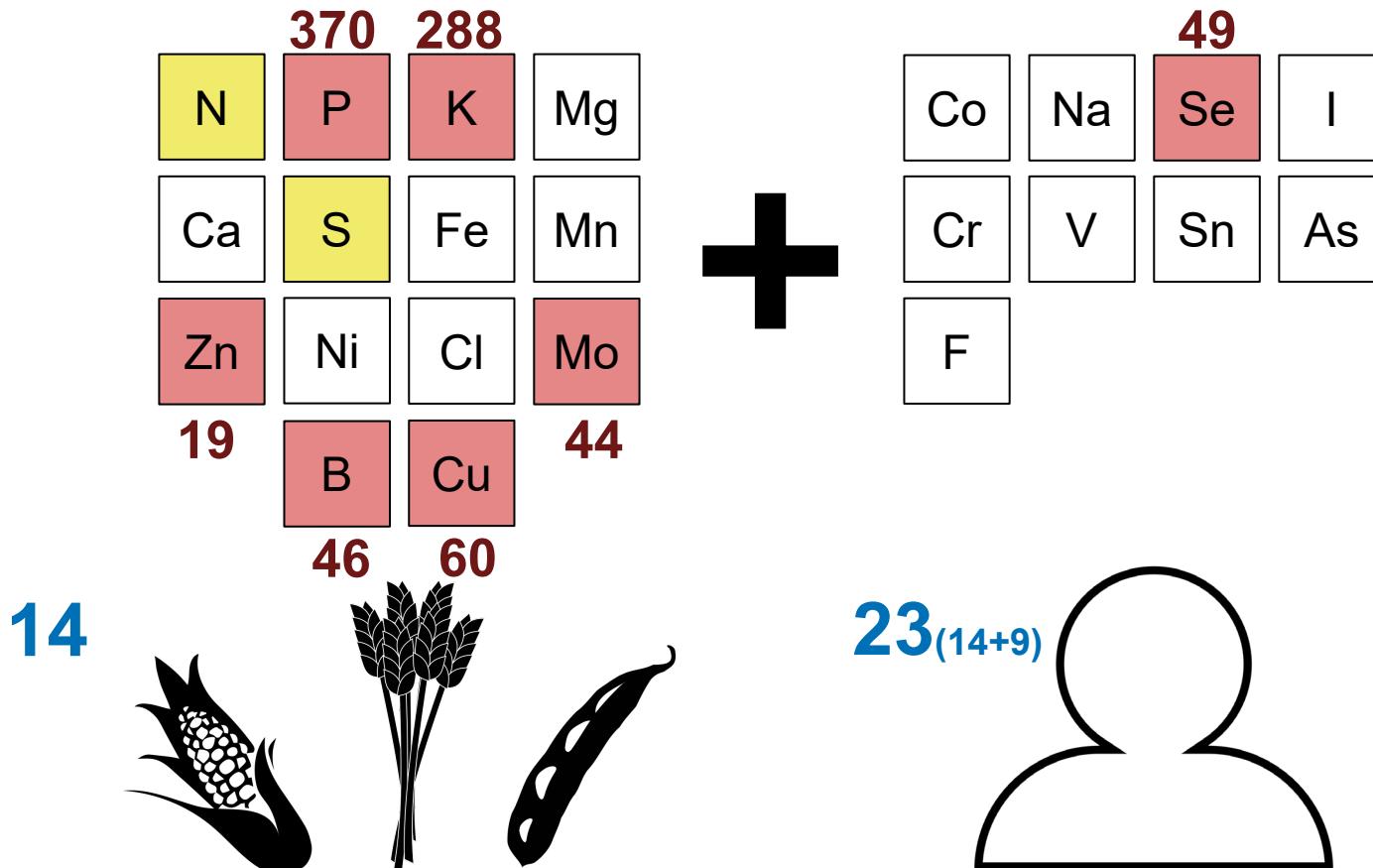
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Scarce elements Reserves in years



Scarce elements Reserves in years



Planetary boundaries

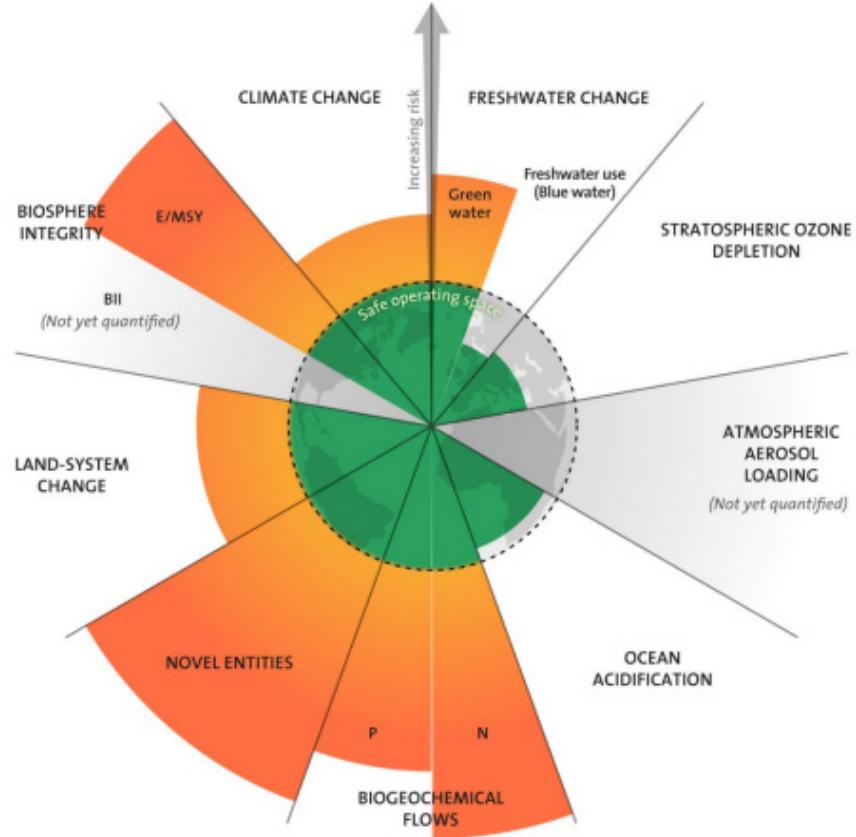
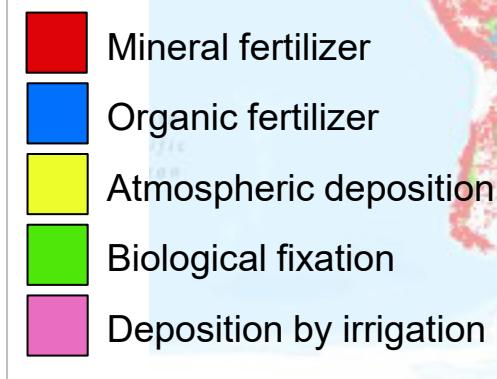
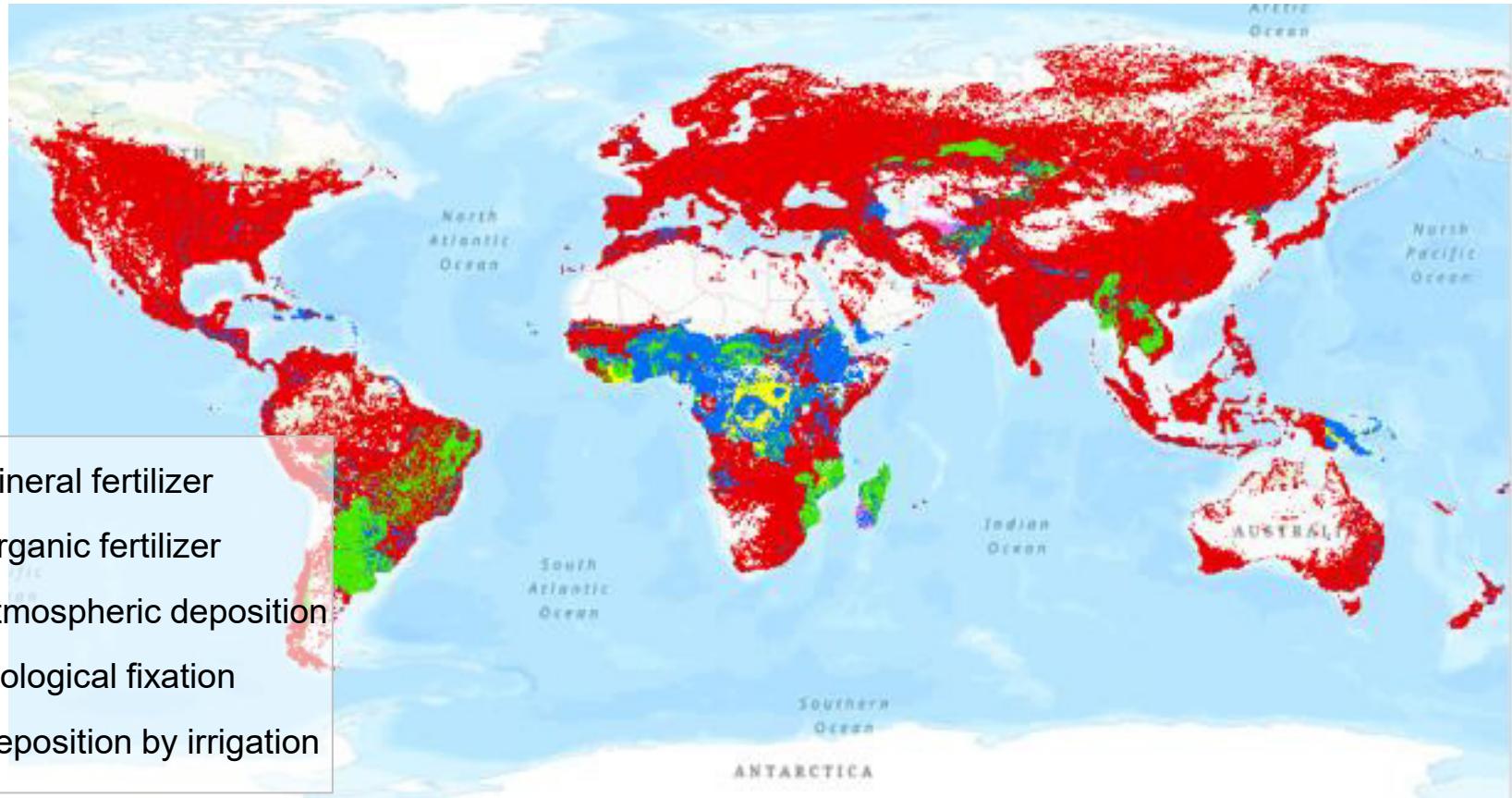


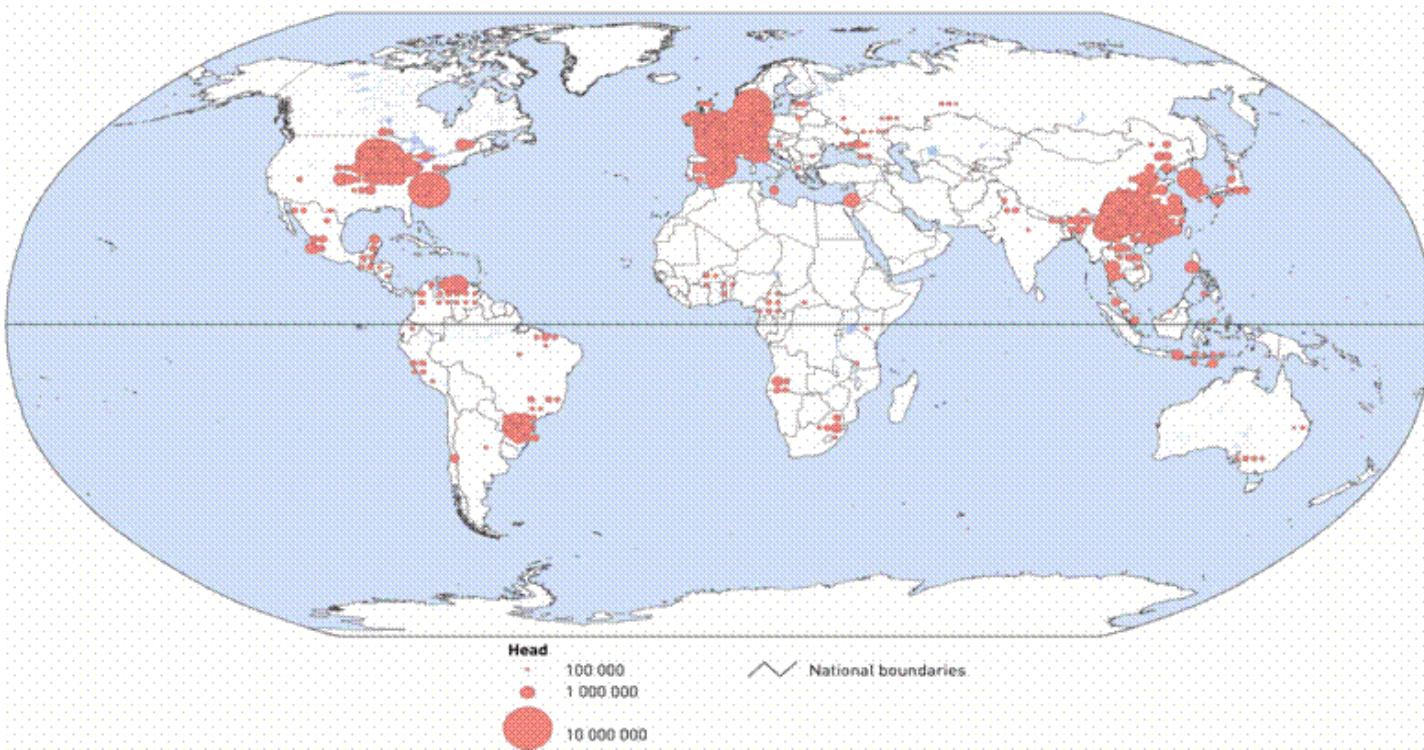
Figure 1. Planetary boundaries as summarized by the Stockholm Resilience Centre (Steffen et al. 2015; Stockholm Resilience Centre, 2022).

Stikstof komt voornamelijk als kunstmest op het land

N

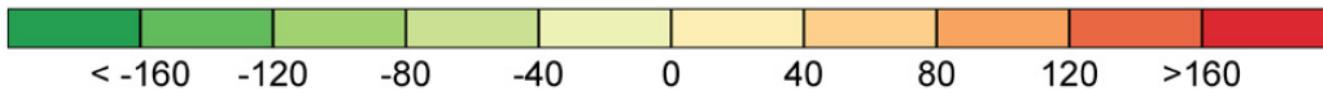
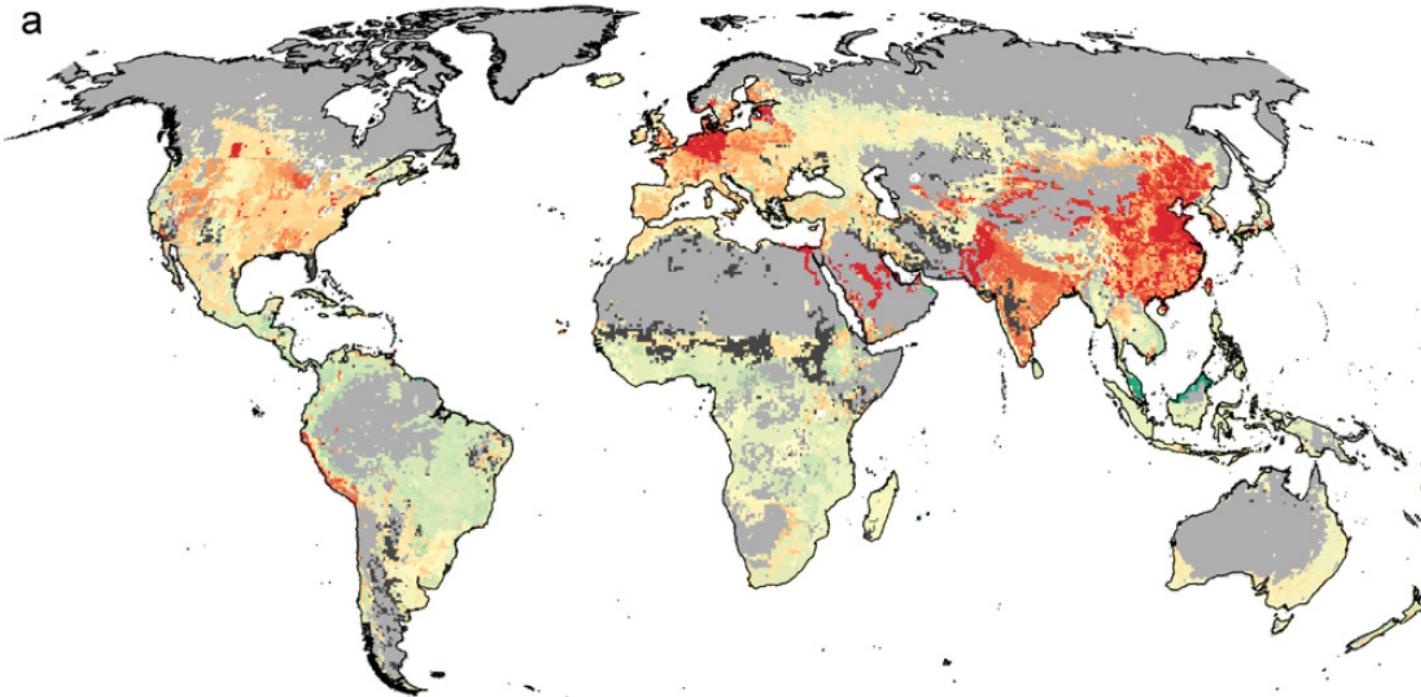


Hotspots of population and livestock



Figuur 2.3 Aantallen pluimvee en varkens per locatie (bron Steinfeld et al., 2006) Source: Mest en metropolen concept 20181224

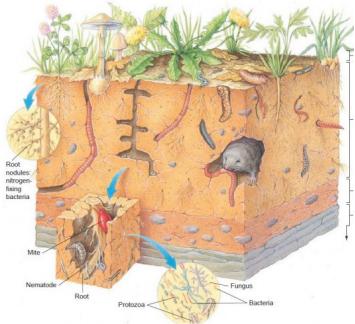
Stikstof input ongelijk verdeeld



Exceedance of critical nitrogen (N) inputs by current inputs [kg N ha⁻¹ yr⁻¹]

Source: L.F. Schulte-Uebbing (2022), Nature

Visie op innovatie

Coherent	<h3>Gezonde levensstijl</h3> 	<h3>Bodemorganisme</h3> 	<h3>Rioolwaterzuivering</h3>  <p>Bron: lv-groep.nl</p>
Niet coherent	<h3>Medicijnen</h3> 	<h3>Pesticide</h3> 	<h3>PFAS</h3>  <p>industry pans fire extinguisher raincoat</p>

Guiding principles

Renewable



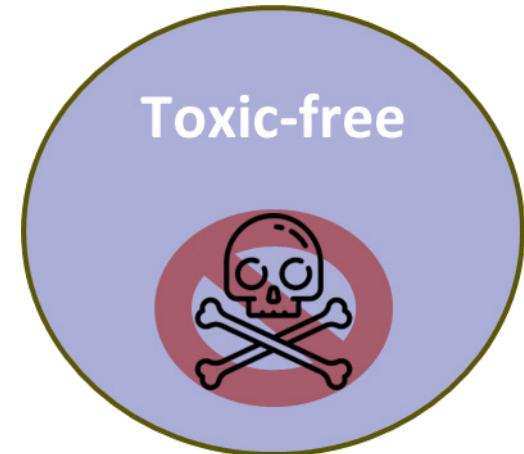
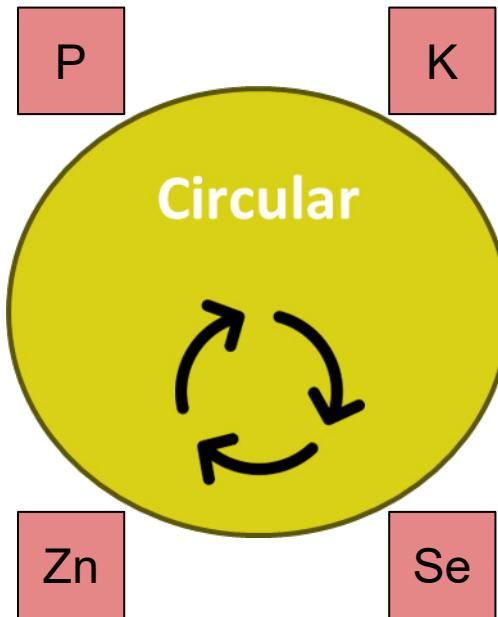
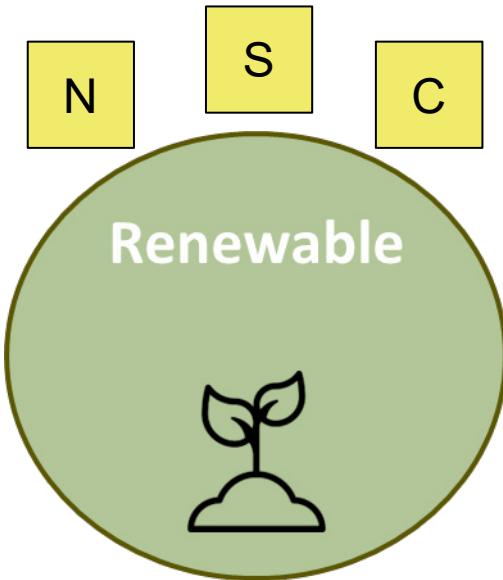
Circular



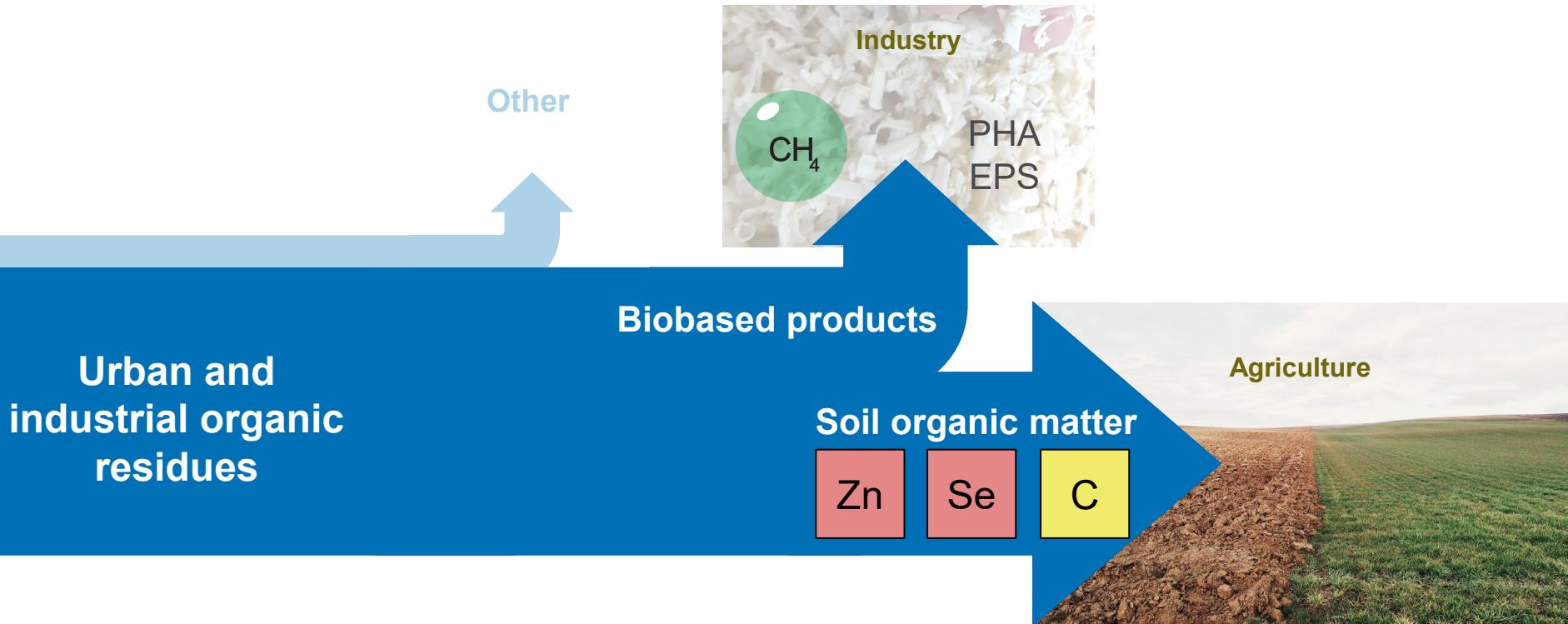
Toxic-free



Guiding principles



Biobased products or agriculture?

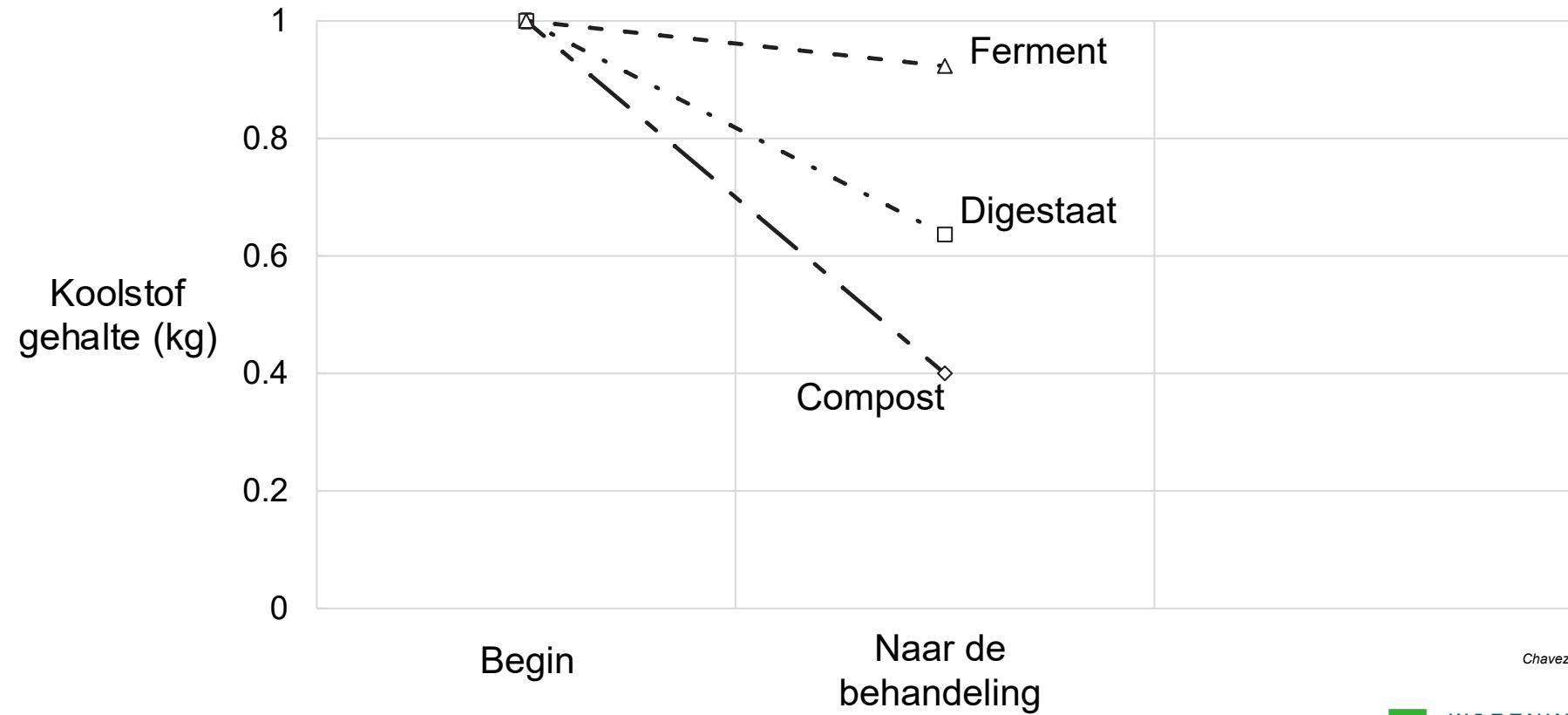


Meer koolstof in bodem met ferment en digestaat



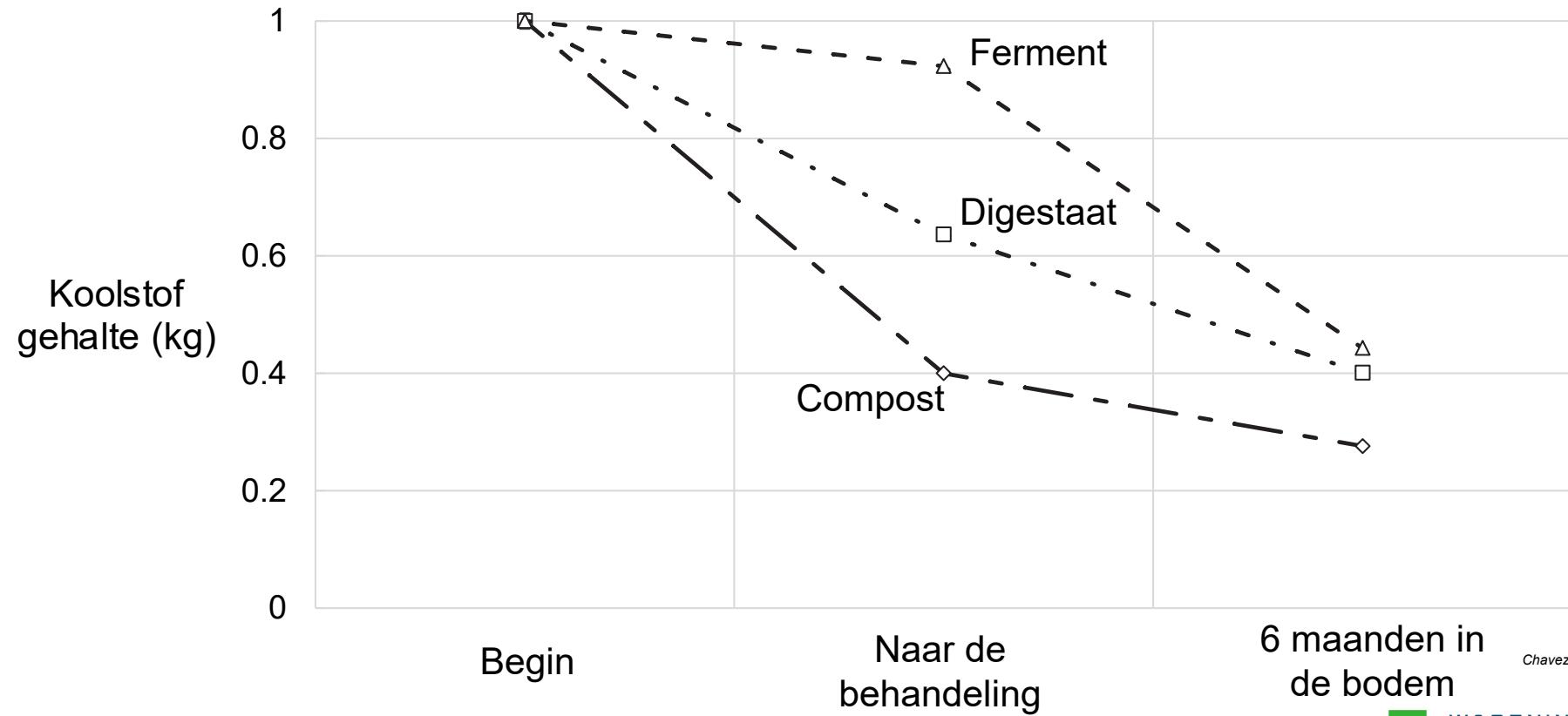
Chavez et al. (2022)

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Chavez et al. (2022)

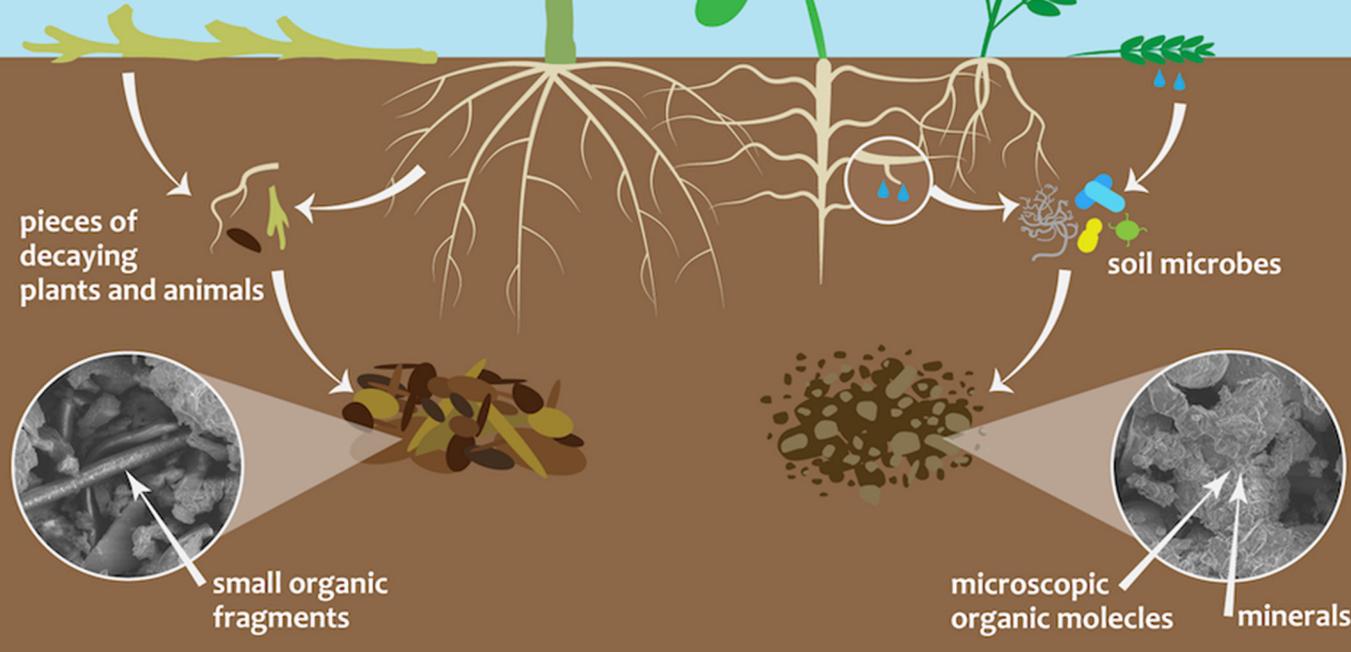
Meer koolstof in bodem met ferment en digestaat



Chavez et al. (2022)

Digestate and ferment leads to higher quality soil organic matter

- **Compost → Particulate organic matter (POM)**
- **Digestate & ferment → Mineral associated organic matter (MAOM)**



particulate organic matter

lifetime
=
1-50
years



carbon
nitrogen

mineral-associated organic matter

lifetime
=
10-1000
years



carbon
nitrogen

Mix – Macroaggregate

Taken by Vania Chavez

Soil organic matter (SOM) different per treatment

C



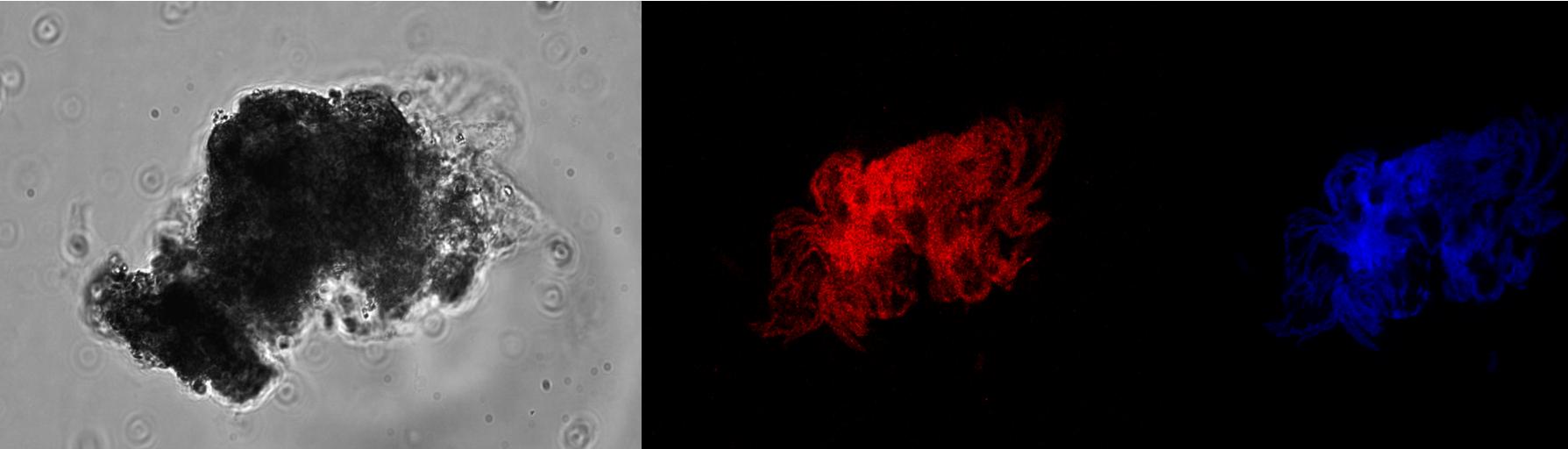
Compost

Ferment

Digestaat

Chavez et al. (2022)

Microorganisms produce EPS



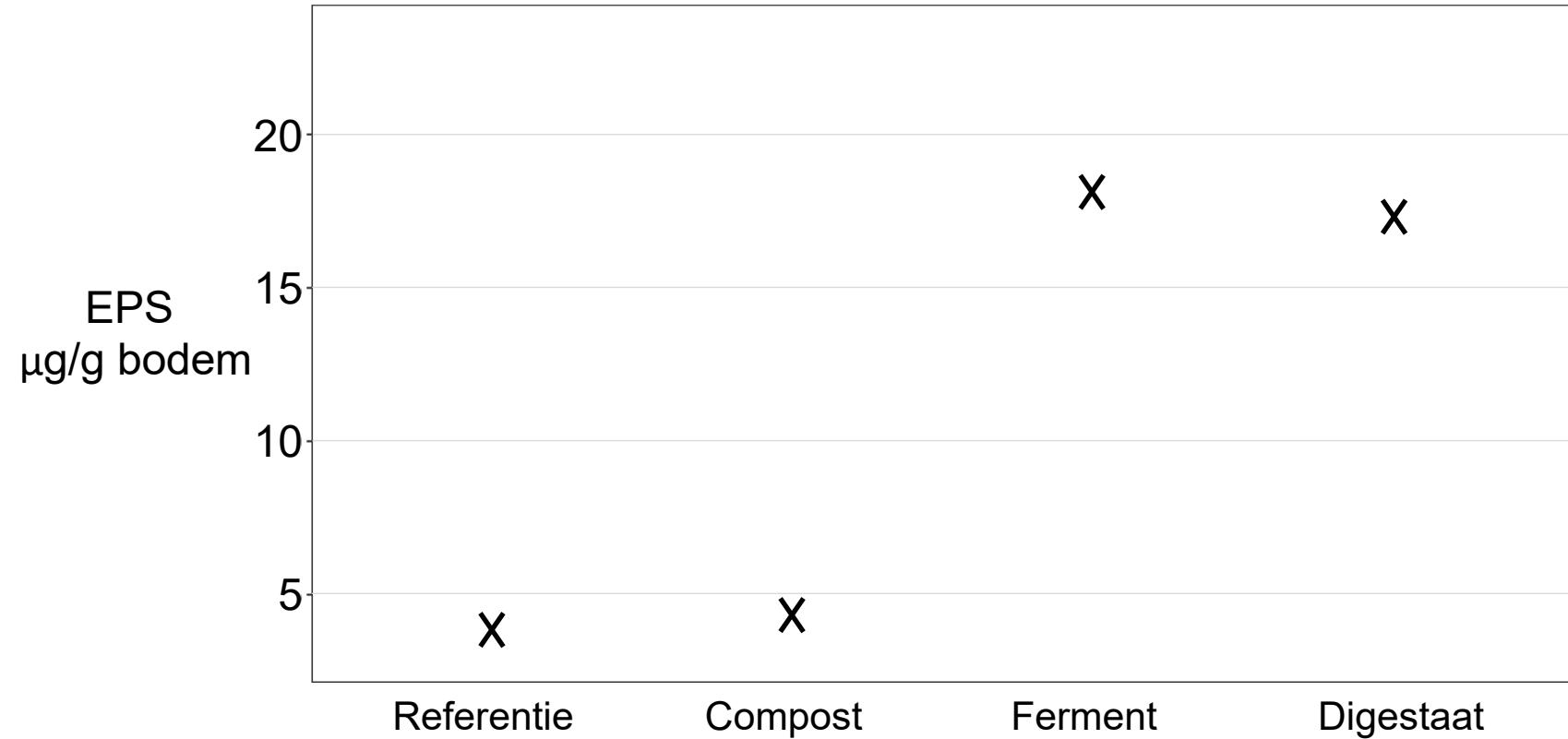
Soil aggregate

DNA of living cells

EPS

Source: Luo et al. 2022

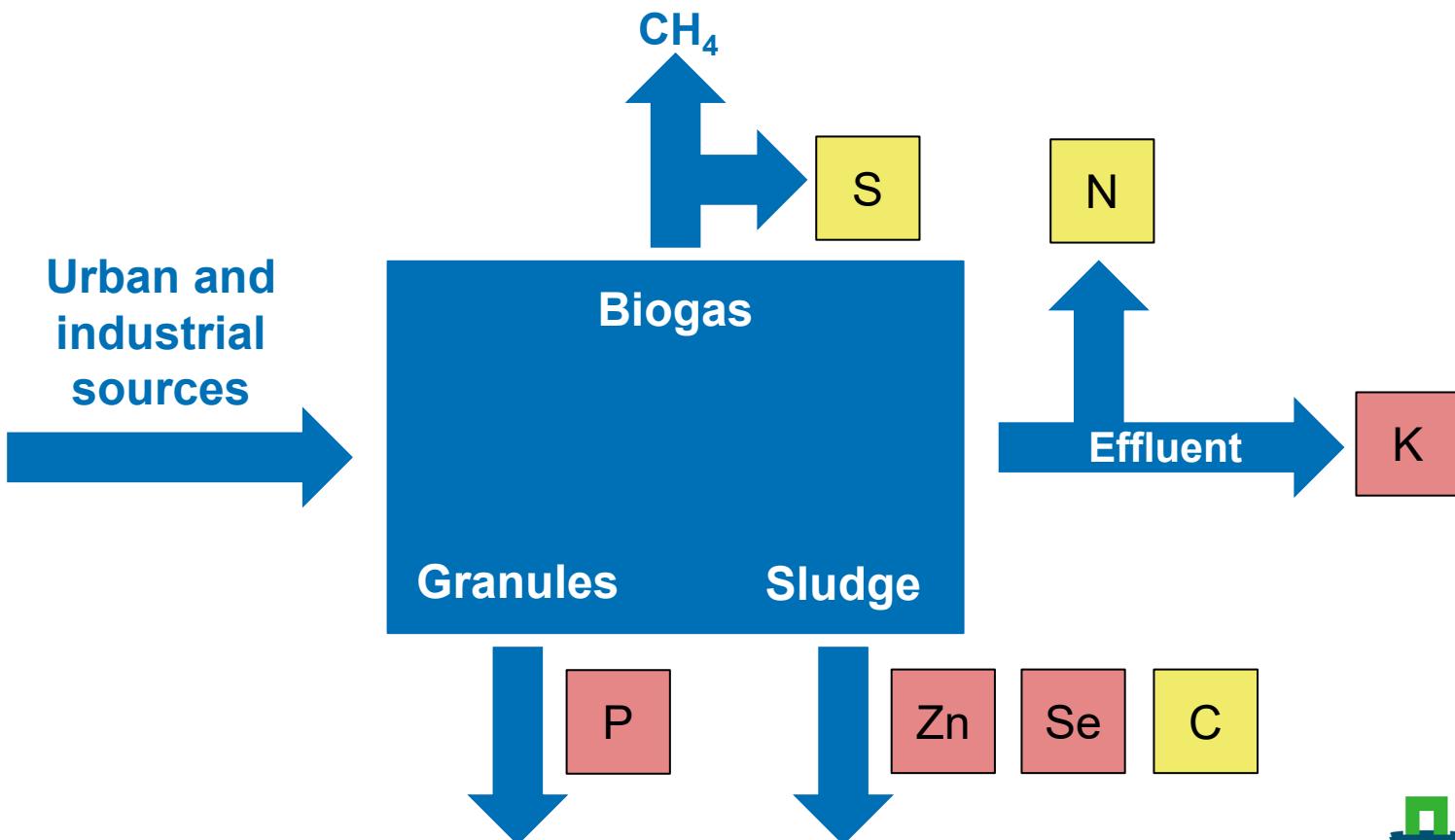
Meer EPS van fermentatie en vergisting



Source: Luo et al. 2022

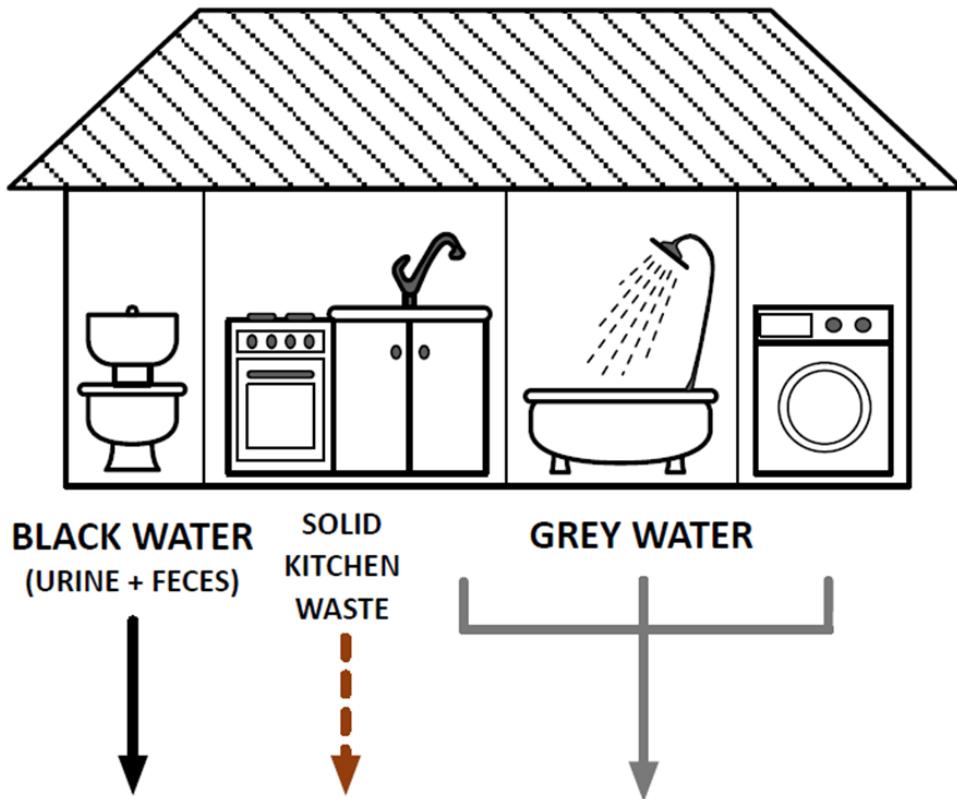


AD as recovery motor





Source separated sanitation



Clean sludge containing trace elements

Black water sludge

	Conc. mg/mg TS	NL guideline
Zn	284	300
Ni	46	30
Cu	95	75
Cr	77	75
Hg	0,01	0,75
Cd	0,71	1,3
Pb	1,4	100
As	0,31	15

Source: Cunha et al. 2020

First pilot | Sneek, NL



Source: Hernandez Leal et al. 2008

Growing and scaling | Sneek, NL



2000 houses | Helsingborg, SE



Recovered P is healthier

	Mined P	Recovered P
Cd	23	0.18
Sr	1057	n.d.
U	141	n.d.
Cr	148	39
	mg kg ⁻¹ _{TS}	

Source: Cunha et al. 2020

6kV

X3,000

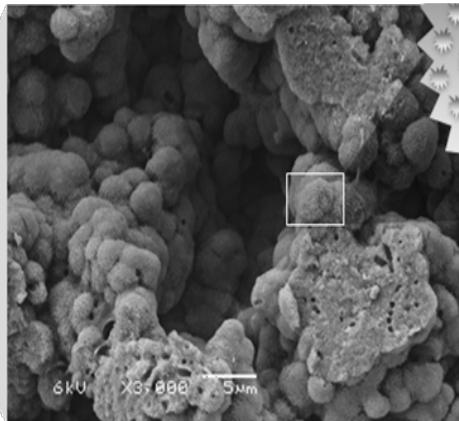
5μm

Recovered calcium phosphate granules



Average ~1.4 mm

Amorphous and hydroxyapatite
77% average crystallinity



Average wt%

P	10
P_2O_5	23
Ca	25
Organics (VSS)	29
Mg, S, and Na	0.9

Source: Cunha et al. 2020

Stikstof: Fosfaat verhouding niet optimaal in mest

N:P / ha

8

6

4

2

0

Optimaal

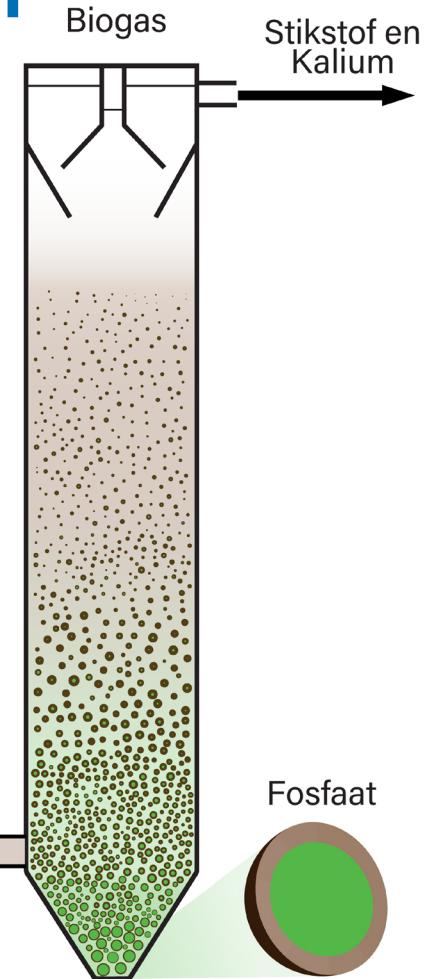
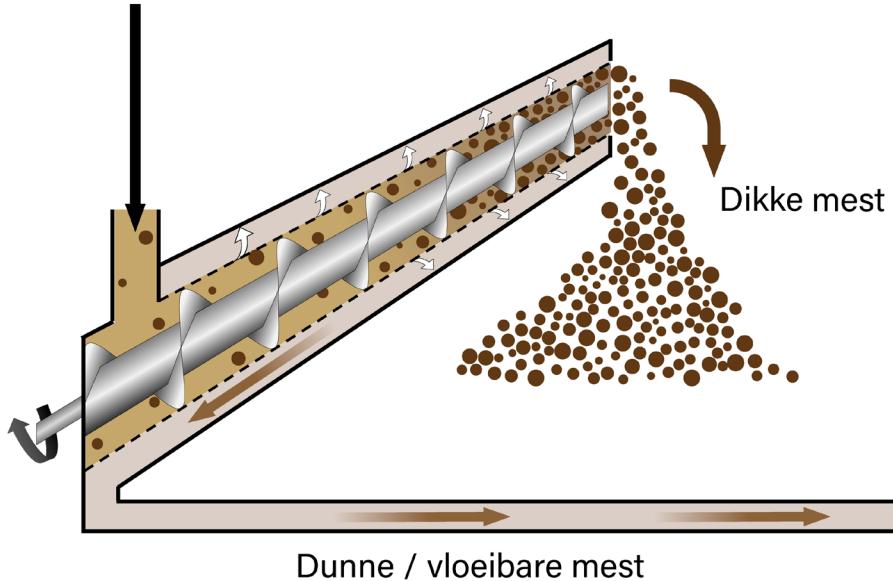
Koeienmest 

Varkensmest 

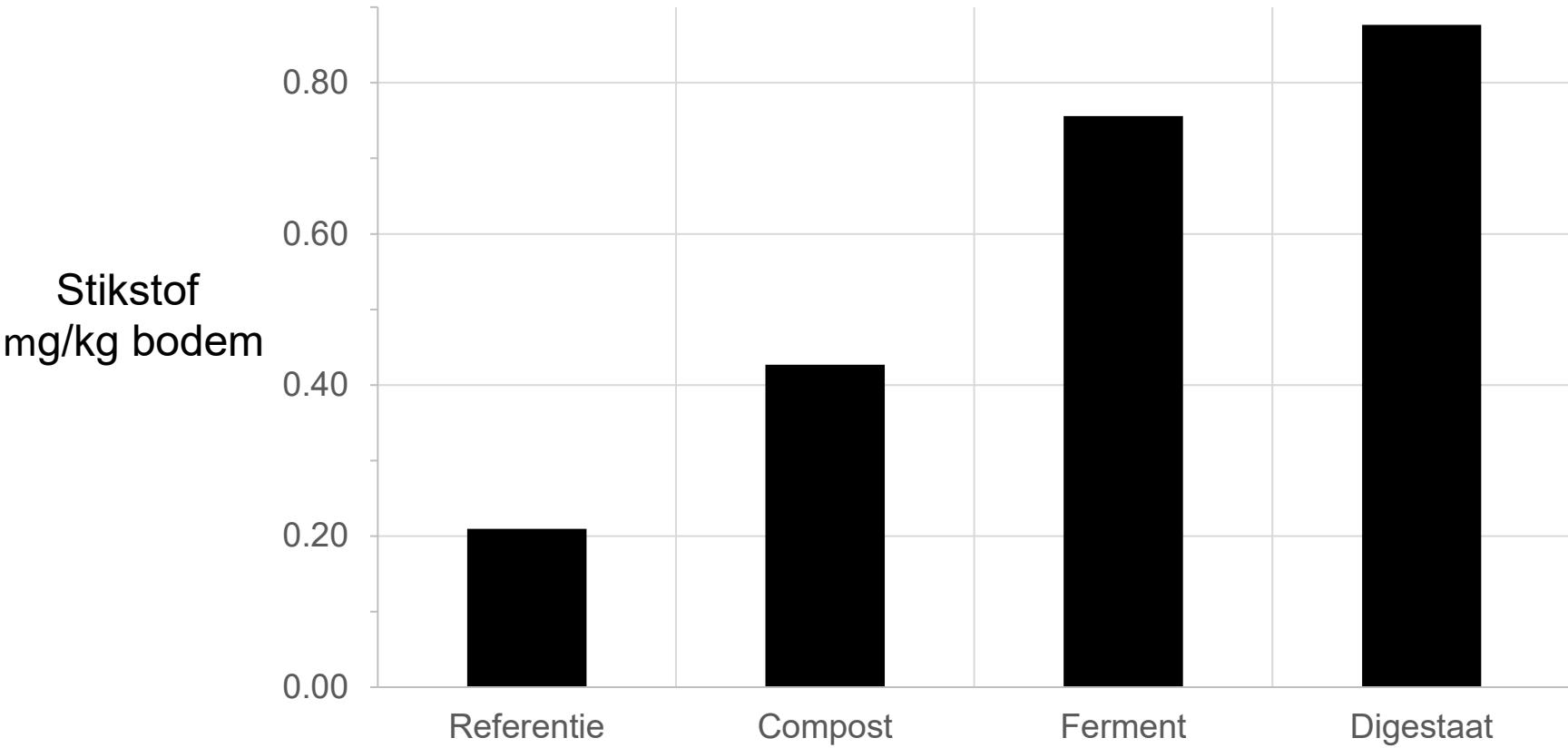
Door vergisten nutriënten splitsen



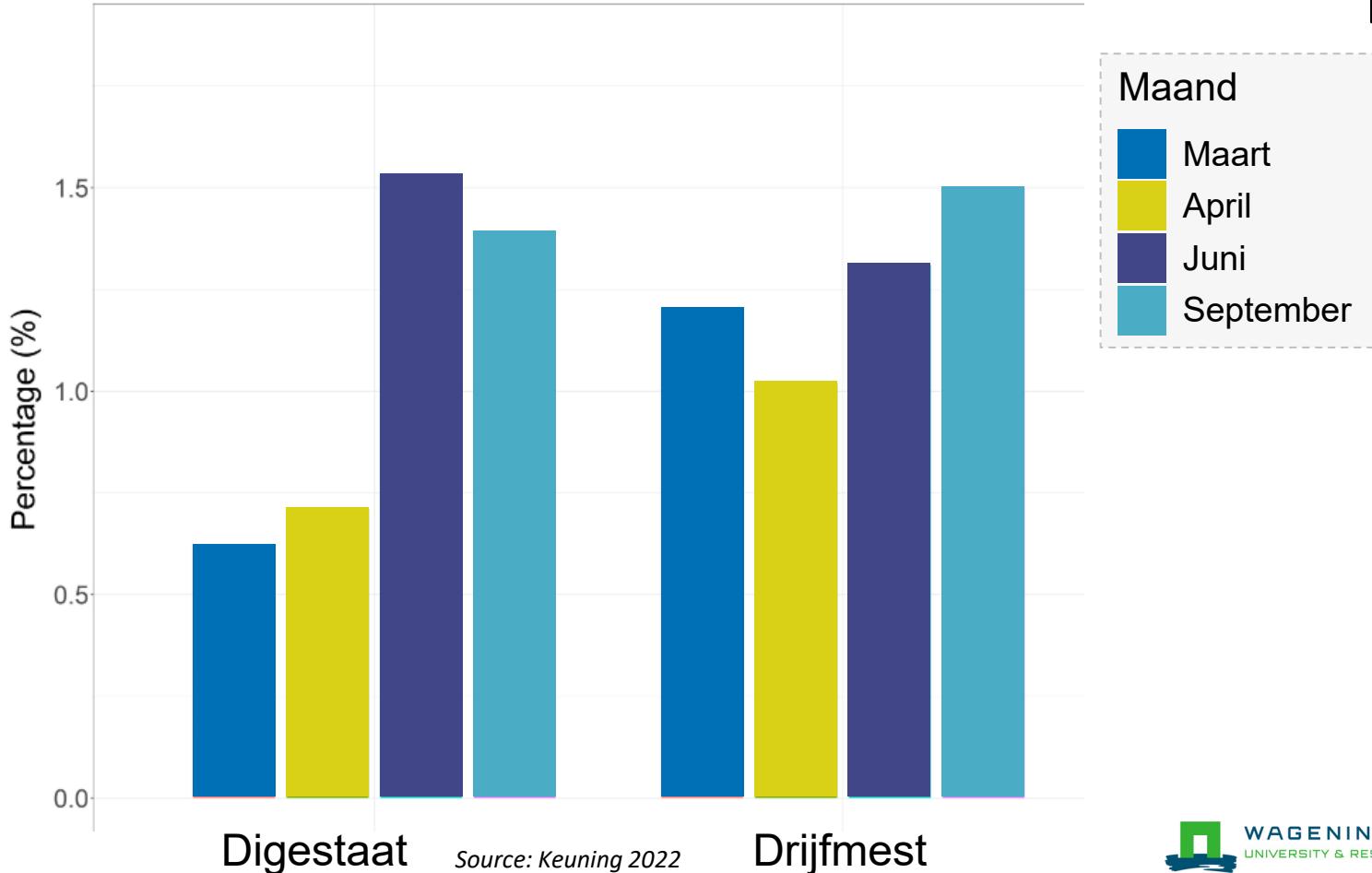
Dierlijke mest



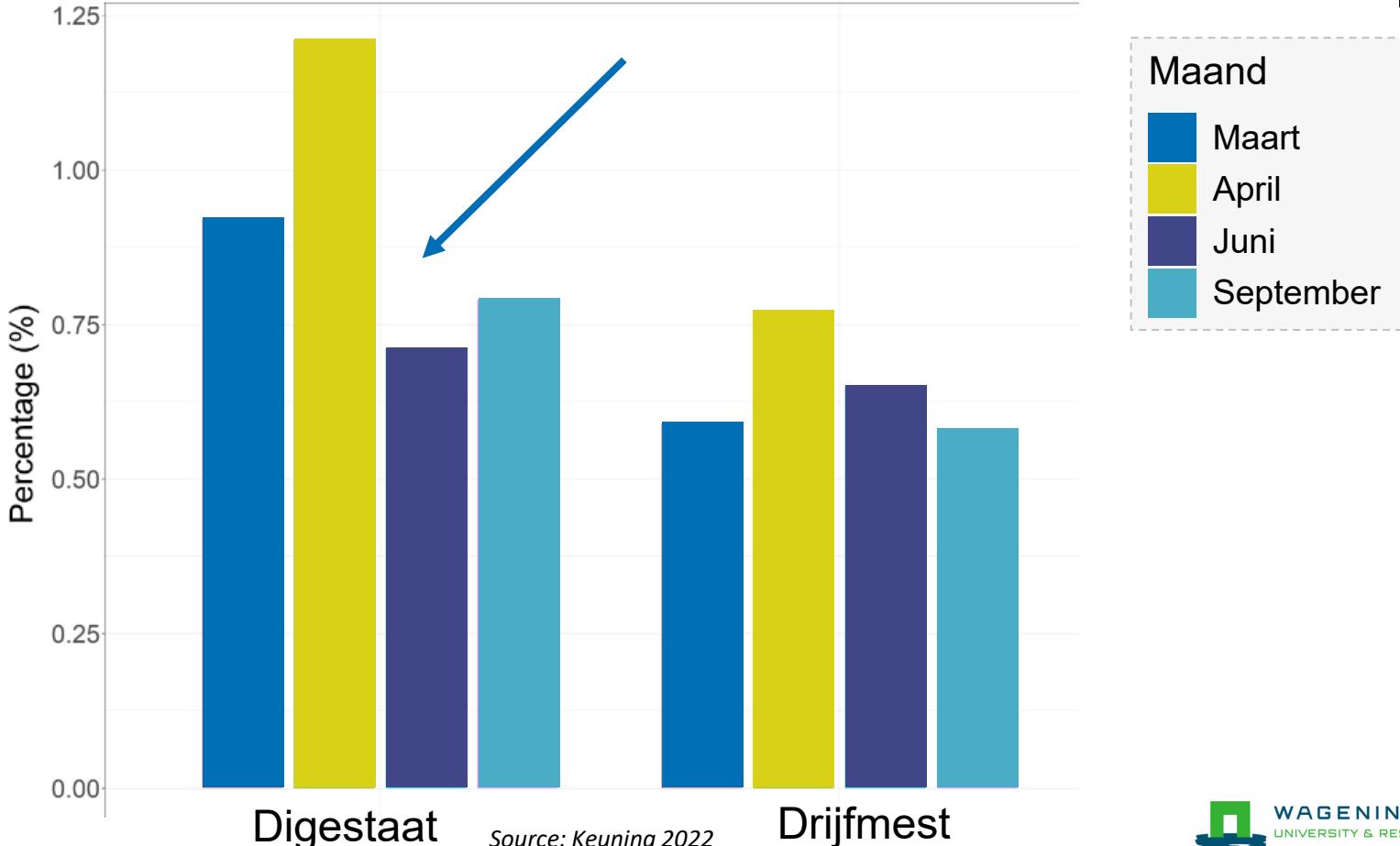
Meer stikstof in ferment en digestaat



Stikstof vastlegging

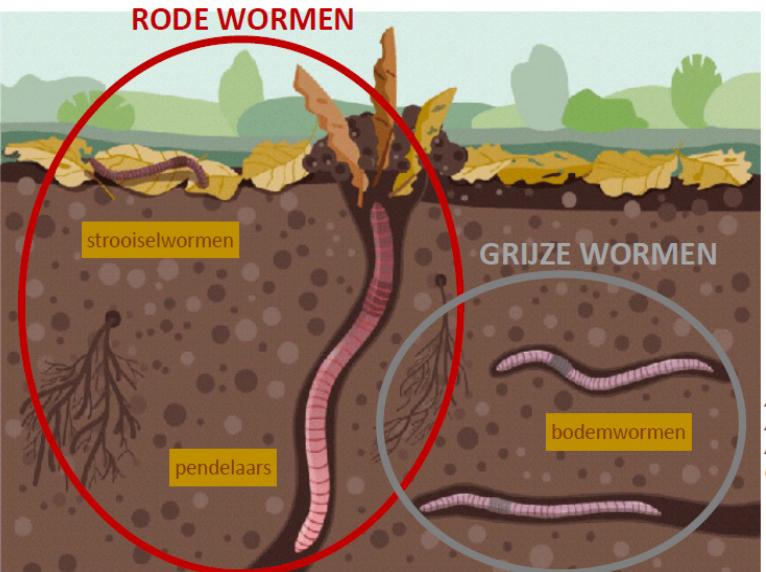


Nitrificatie neemt toe naar mestgift



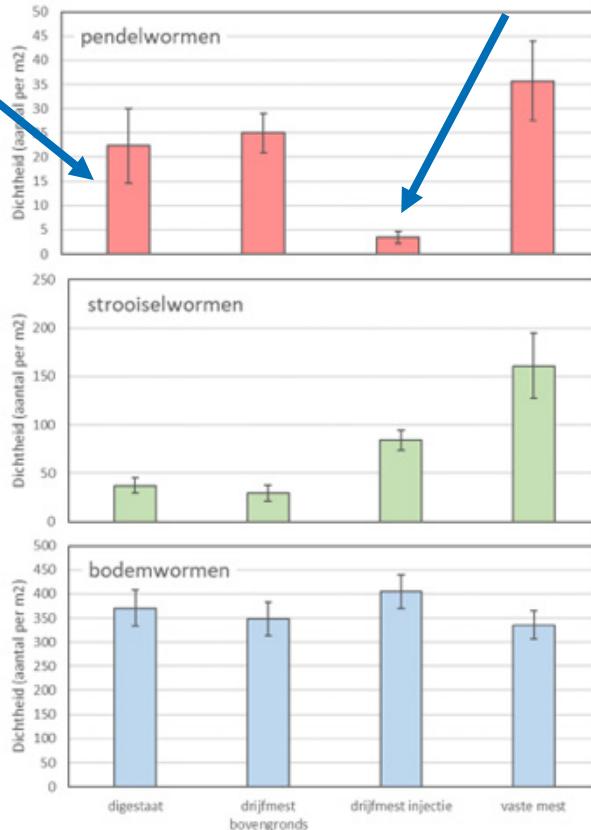
Houden wormen van digestaat?

Ecologische Groepen Regenwormen

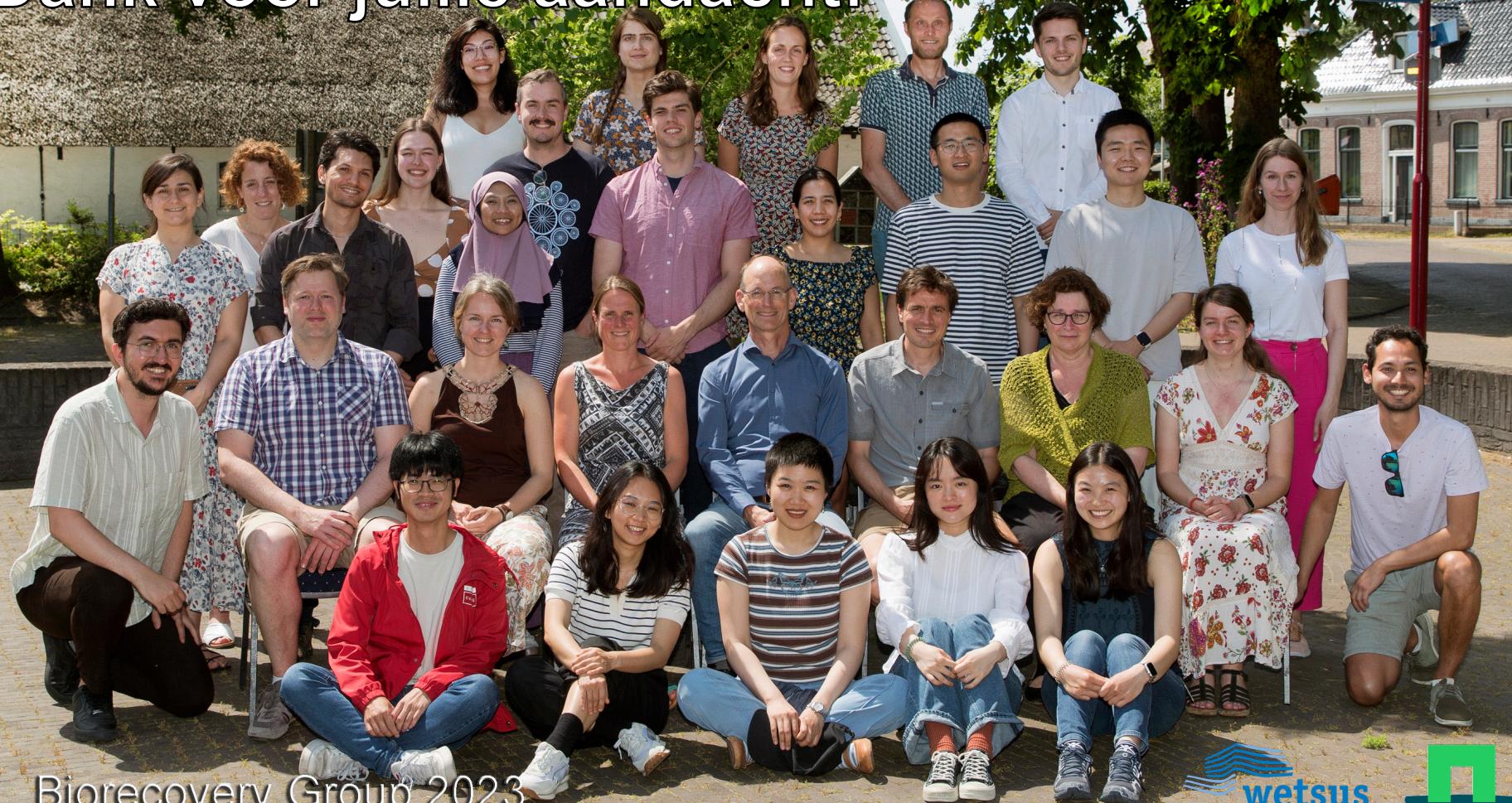


Jeroen Onrust PhD

Source: Keuning 2022



Dank voor jullie aandacht!



Biorecovery Group 2023

Thema-avond Bodem

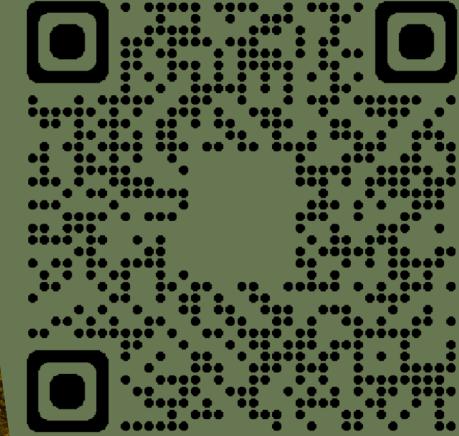
29 November bij Wetsus

Meer informatie op www.wetsus.nl

Voor vragen chris.schott@wetsus.nl



June 3-5, 2024
Leeuwarden



www.wetsus.nl/ecgic-2024

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