GLOBAL RESEARCH ALLIANCE

ON AGRICULTURAL GREENHOUSE GASES

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Lars Stoumann Jensen, Professor, UCPH

Developing new bio-based fertilisers from organic waste upcycling for optimal use in agriculture

- and training a new generation of scientist for the challenge!

Developing new bio-based fertilisers from organic waste upcycling for optimal use in agriculture - and training a new generation of scientist for the challenge!

Brief bio:

Lars Stoumann Jensen

- **Professor of Soil Fertility and Organic Waste Recycling**
- Head of the Plant & Soil Section at PLEN, UCPH

Profile

- Long research career focused on soil fertility & CNP cycling, recycling of manures & organic waste, GHG & NH3 emissions, soil C sequestration, dynamic soil-plant-atm modelling, LCA
- Currently involved as partner/PI in a number of EU and national research projects on these topics
- Principal Coordinator of the **FertiCycle** MSCA training network
- WP4 lead and partner in the **LEX4BIO** EU H2020 project

UNIVERSITY OF COPENHAGEN

Dept. of Plant & Environmental Sciences (PLEN)

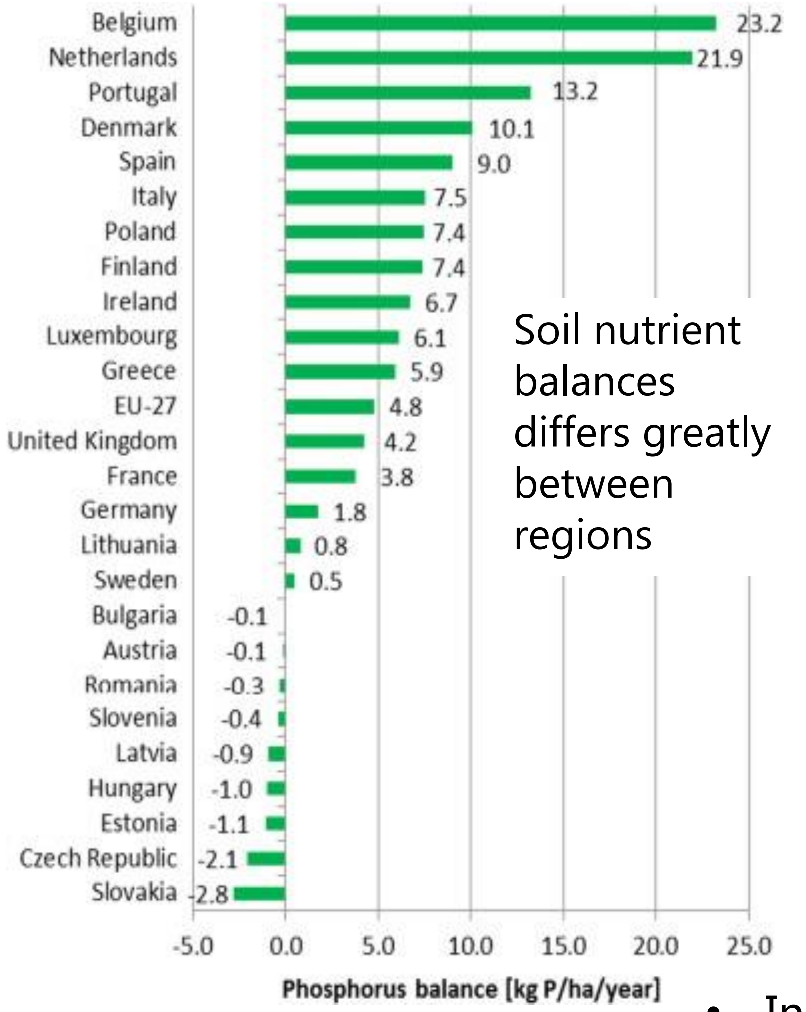
Insights from the EU projects

LEX4BIO

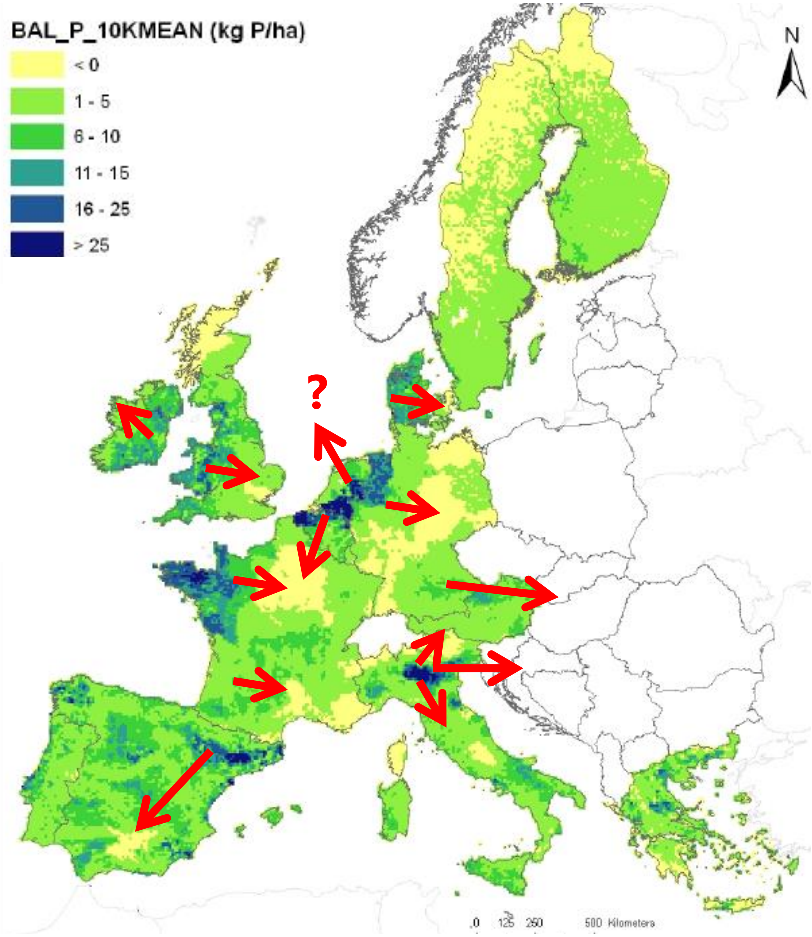
FertiCycle

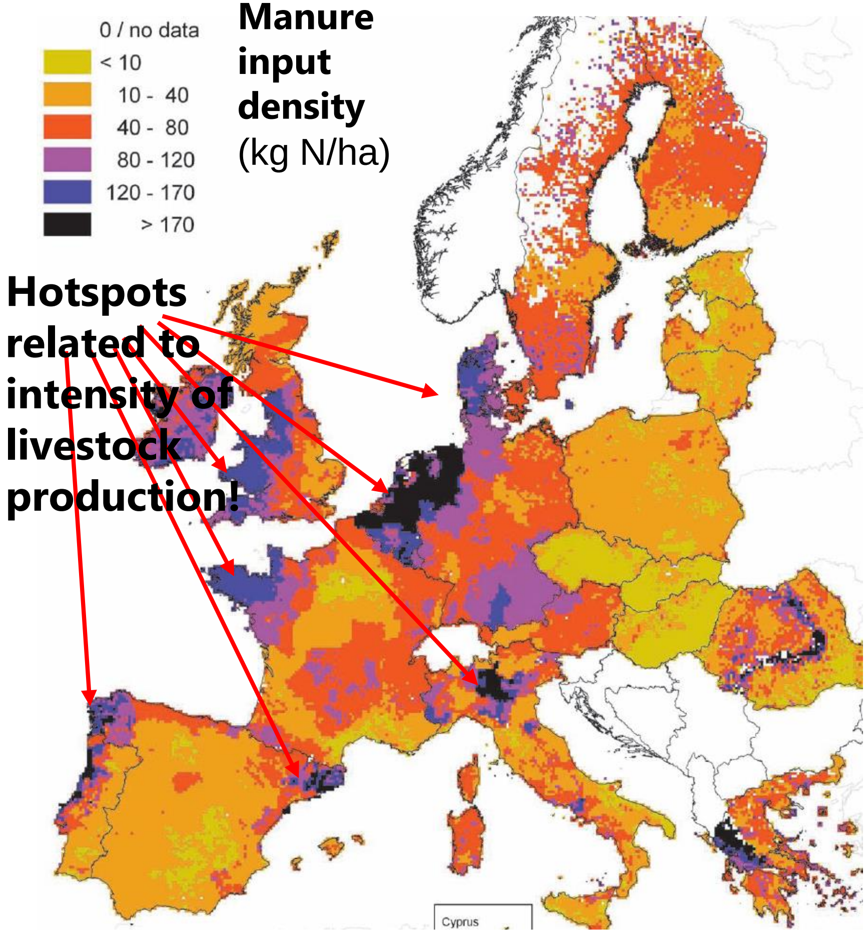
These projects have received funding from the European Union's Horizon 2020 research and innovation programme under the grant agreements No. 860127 and 818309

Background – European challenge: N & P hotspots



Soil nutrient balances differs greatly between regions



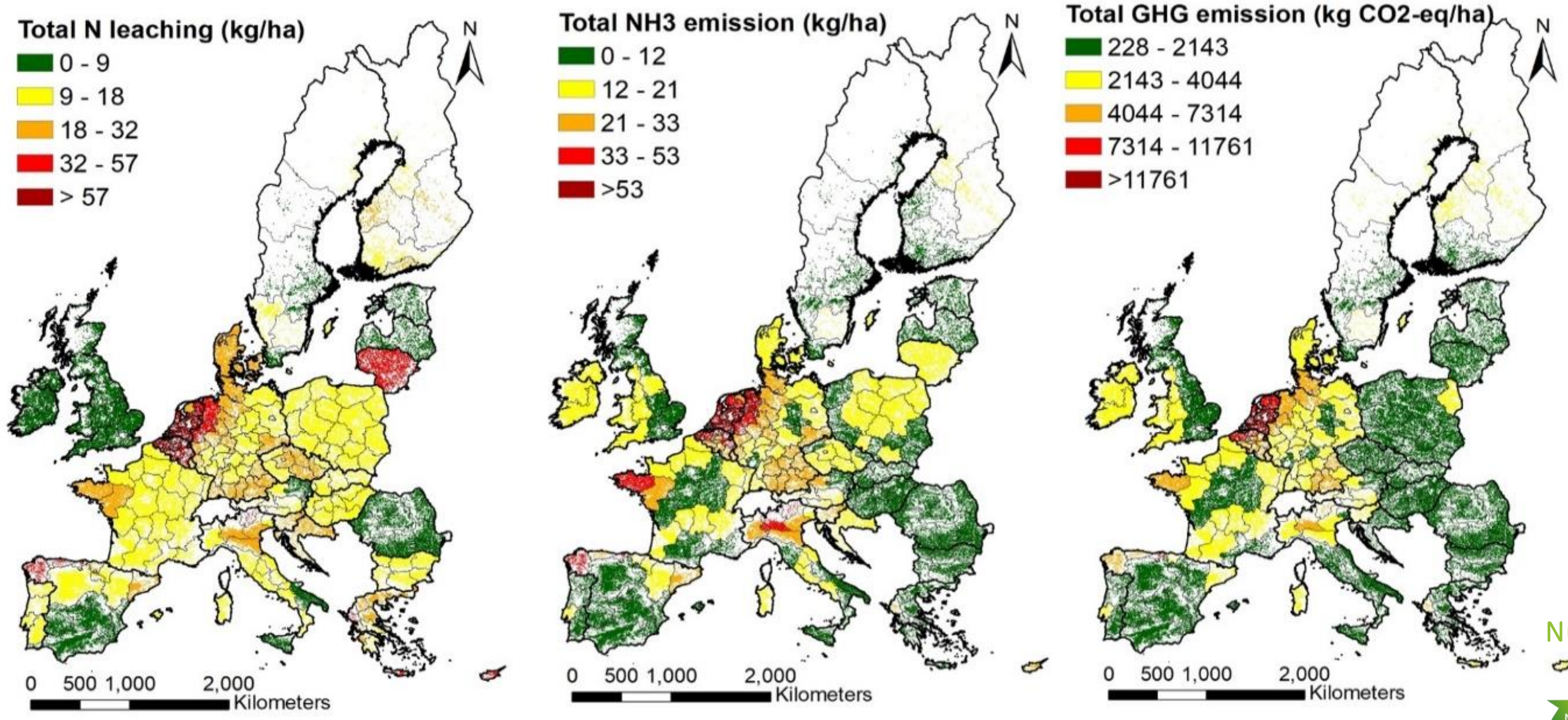


Van Dijk et al. 2016

- In order to protect the atmospheric and aquatic environment, political demand for implementation of environmental regulations / technologies
- **Need for redistribution of surplus N & P – raw or processed**

Thise projects have received funding from the European Union's Horizon 2020 research and innovation programme , grant agreements No.860127 (FertiCycle) and 818309 (LEX4BIO)

Background - N leaching, NH_3 & GHG emissions from EU agriculture



(Duan et al. 2020, Nutri2Cycle D1.5 report)

Nutri2Cycle

All clearly related to intensity and form of agricultural activity

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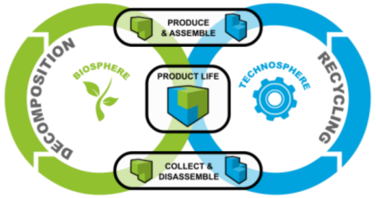
Background – why focus on bio-based fertilisers?

- Global population growth, food demand & food security needs
- Planetary boundaries ➔
  - Global - and European - **N** and **P overload** to the environment
- Scarce resources (**P** and **energy**), protect the environment
- Need for **recovery** and **recycling** of excess nutrients from agricultural, industrial and urban **waste streams**
- Circular economy policies globally (EU, China, etc.) ➔
  - The new **EU Fertiliser Regulation** (in force from mid 2022) will include **bio-based agricultural fertiliser** products
- Organic-agriculture market expansion in affluent countries ➔
  - increasing demand for **eco-labelled, certified, recycled organic fertiliser**



European Commission

Thise projects have received funding from the European Union's Horizon 2020 research and innovation programme , grant agreements No.860127 (FertiCycle) and 818309 (LEX4BIO)

Background - N and P recycling potential in the EU

Table 1. EU nutrient recycling potential, total amounts and average amounts per year on agricultural land in the EU if spread evenly (Eurostat 2016, Leip et al. 2014, Velthof et al. 2015, van Dijk et al. 2016, Sutton et al. 2011, Buckwell & Nadau 2016). For comparison, annual mineral fertilizer use (Eurostat 2016).

	N total Mt	N average kg/ha/a	P total Mt	P average kg/ha/a
Manure	7–9	41–52	1.8	10.5
Biowaste	0.5–0.7	2.9–4.1	0.1	0.6
Slaughterhouse waste	ND	ND	0.3	1.7
Sewage	2.3–3.1	13.3–18.0	0.3	1.7
Mineral fertilizer	10.9	63	1.4	8.1

ND = no data

- Manures dominate
- These are already to a great extent recycled – <u>but not optimally</u>
- Other sources are only partly utilised – still significant potential

(Luostarinen et al. 2020. http://urn.fi/URN:ISBN:978-952-380-037-3, SuNaMu final project report)

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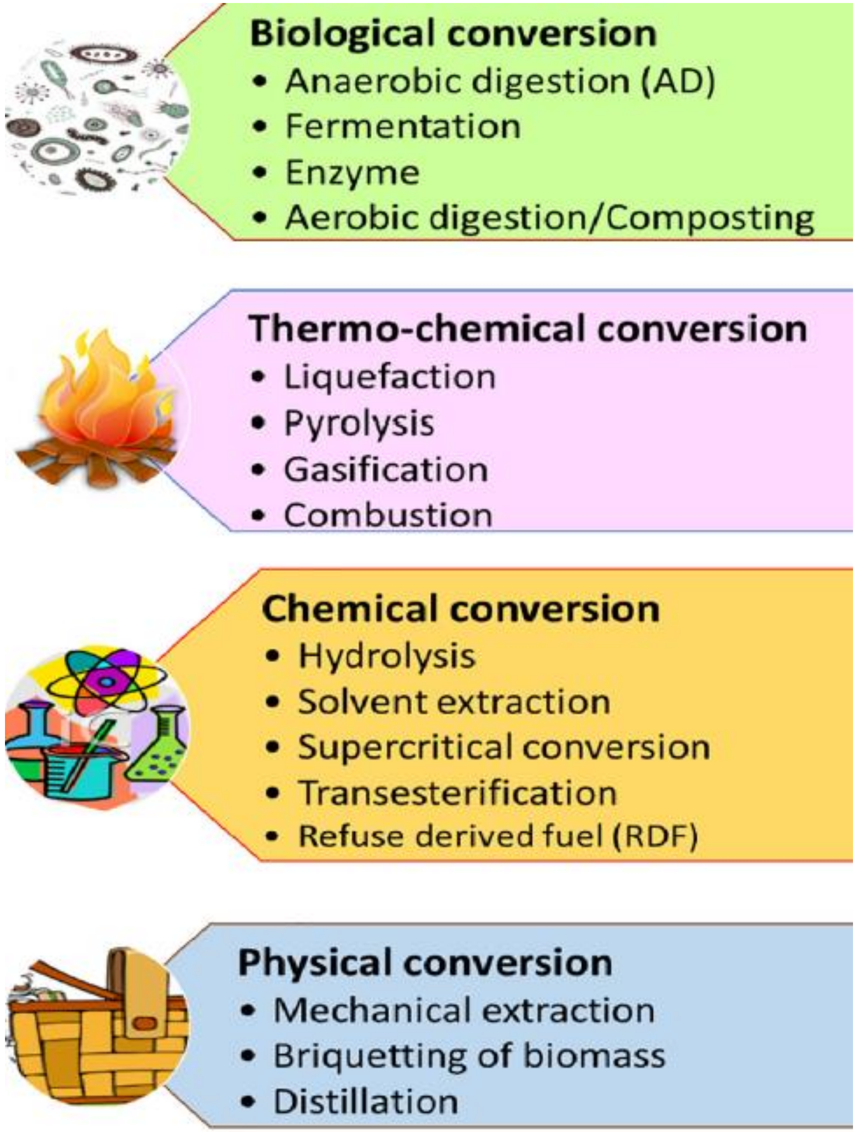
Technologies to process org. waste into bio-based fertiliser

Processing to improve bio-based fertiliser quality:



A.S. Nizami et al. / Bioresource Technology 241 (2017) 1101–1117

- Multiple barriers and challenges for this…

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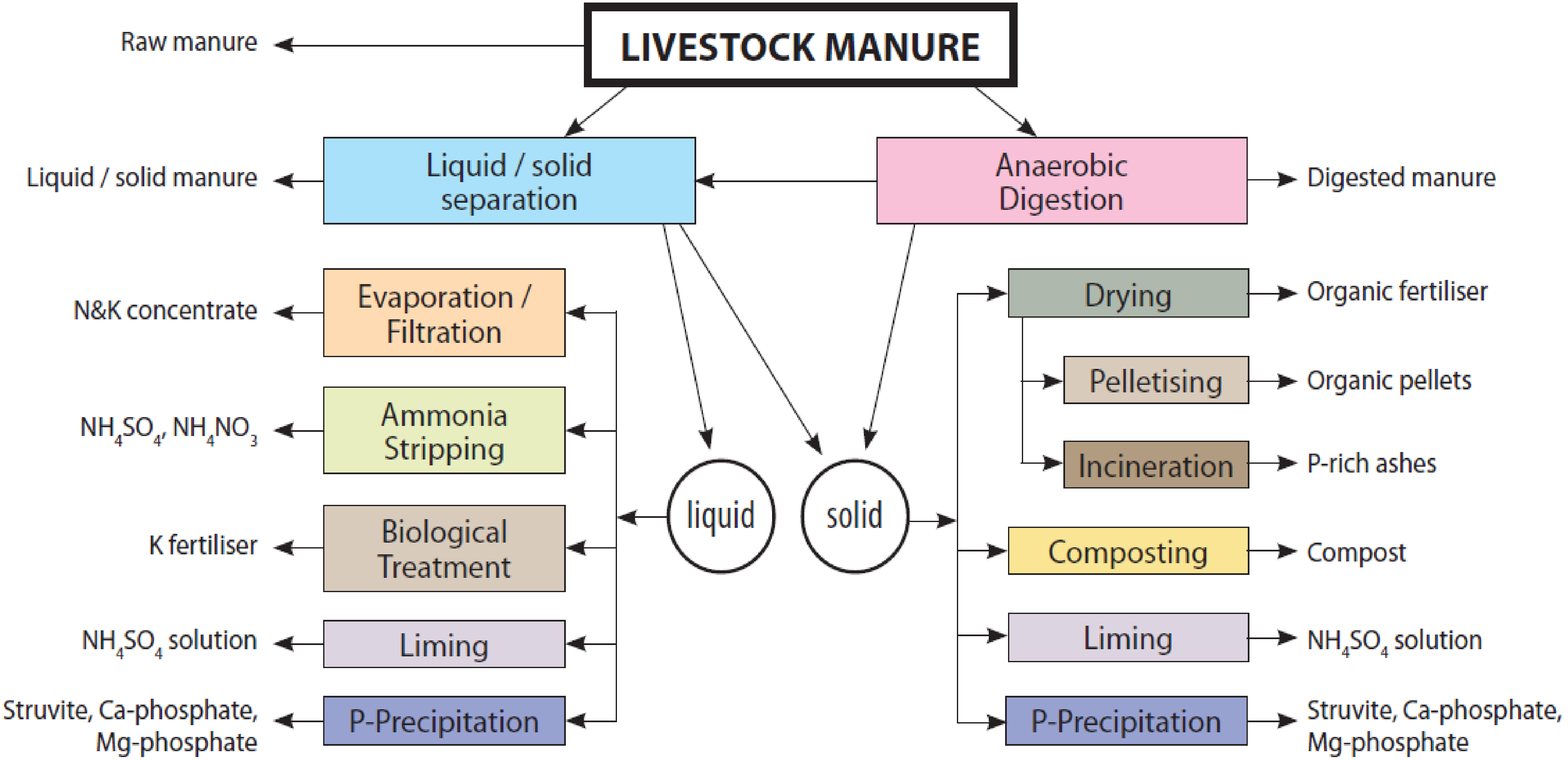
Processing technologies for more advanced nutrient recovery and recycling from manures, urban industrial org. waste streams



- High-tech manure processing technologies already on the market (TRL9)
- But so far only applied in regions with high N/P surplus (Netherlands, Flanders, Catalonia,···) due to high installation & running costs
- Cheaper alternatives (e.g. direct application =surplus) often preferred

(Buckwell and Nadeu, RISE, 2016)

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Processing of organic waste streams produces bio-based products with special challenges

Digestates
– manure or plant based

Solid fraction / Composts

Liquid fraction

Mineral concentrates
e.g. $(NH_4)_2SO_4$ from NH_3 stripping

Precipitates,
e.g. struvite, Ca-phosphates

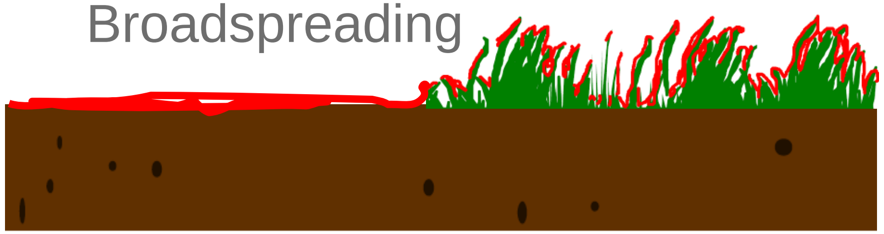
Traditional and simply processed organic biowaste products often have:

- low nutrient concentrations and high volume
- slow/variable/uncertain nutrient availability
- inappropriate nutrient ratios (N:P:K:S:etc) rel. to plant demand
- higher risk of emissions (NH_3, GHG)
- odour, biosecurity and other nuisances/risks for neighbours

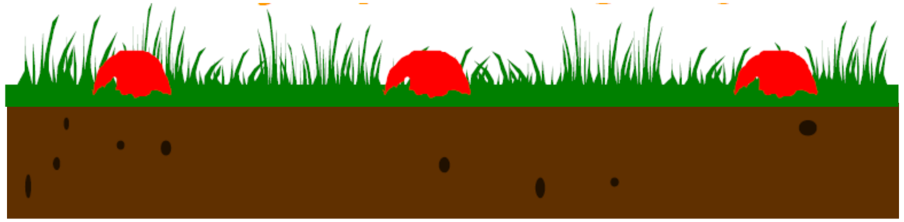
Thise projects have received funding from the European Union's Horizon 2020 research and innovation programme , grant agreements No.860127 (FertiCycle) and 818309 (LEX4BIO)

Logistic challenges: Liquid organic fertiliser application

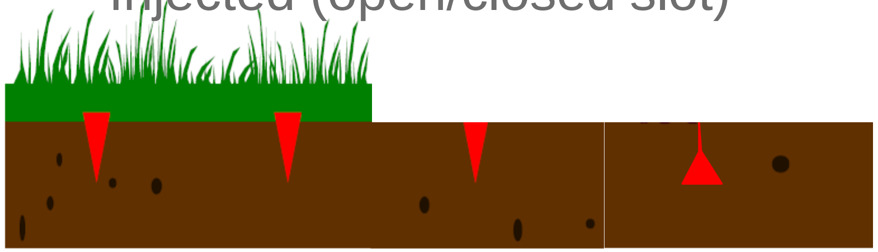
Broadspreading



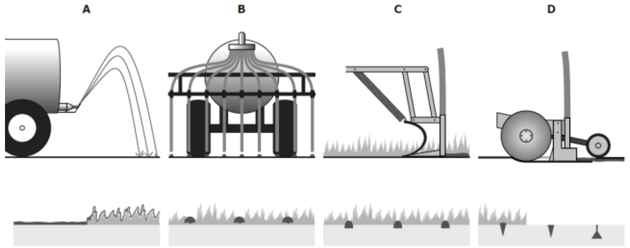
Band application (trailing hoses)



Injected (open/closed slot)



- Not a big technical challenge in countries/regions with advanced manure management
- Huge challenge for other regions and traditional crop farmers



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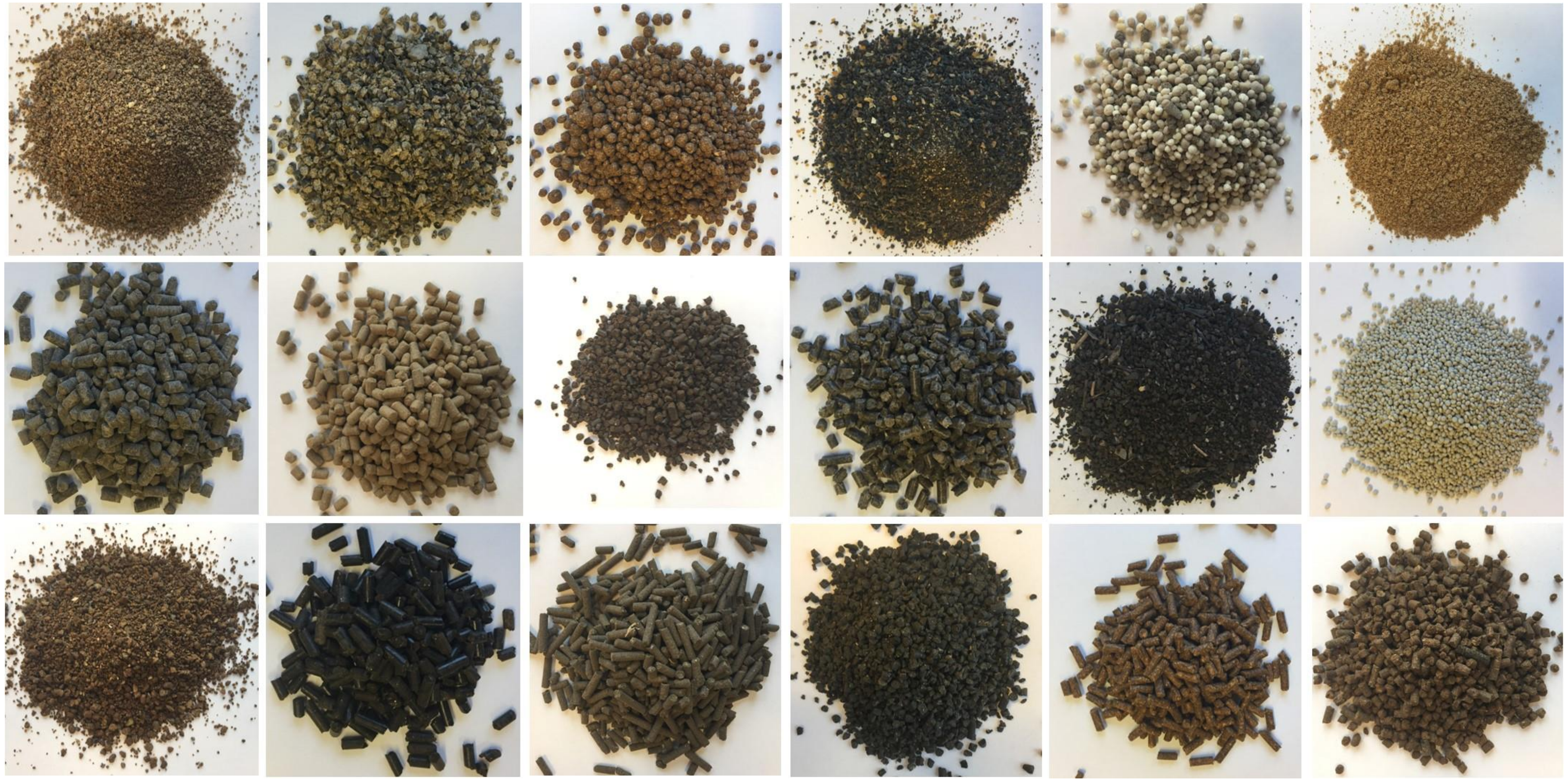
Processing of organic waste streams may produce solid bio-based products with better properties…



(photos courtesy of Lærke W Larsen, LEX4BIO)

Standard and more uniform characteristics

- Pelletisation and physical hardness improves spreading
- Higher and more uniform of nutrient concentration
- More defined nutrient availability profile
- Modified nutrient ratios (N:P:K:S) by mixing feedstocks
- More biol. stable
- Lower emissions?

Thise projects have received funding from the European Union's Horizon 2020 research and innovation programme , grant agreements No.860127 (FertiCycle) and 818309 (LEX4BIO)

Logistics: Solid / pelletised fertiliser application techniques

- Centrifugal spreaders
- Air/pneumatic
- Solid organics spreader

- For a majority of farmers, BBFs spreadable with these types of technologies will be a preference!

Thise projects have received funding from the European Union's Horizon 2020 research and innovation programme , grant agreements No.860127 (FertiCycle) and 818309 (LEX4BIO)

The new EU Fertilising Product Regulation - (EU) 1009/2019

- The new **EU Fertilising Product Regulation** is part of the EU Circular Economy Strategy and linked to both the EU's environmental (Green Deal) and agricultural policy (From Farm to Fork).
- Includes as former regulation **mineral/synthetic fertilisers**, but now in addition also a range of **organic materials and waste products** that have fertilizer value: animal by-products, compost, digestate, plant residues, food waste, etc. Sewage sludge is so far not included.
- Defines **end-of-waste criteria** for when residues / side-streams are no longer waste, but can be used as input materials in fertilizer products
- Includes not just fertilisers, but also **bio-stimulants**, **growth media**, **soil improvers** & **liming agents**
- Ensures **harmonized, common EU limit values** for problematic / hazardous substances as well as producer responsibility (REACH), e.g. heavy metal limits, (currently different national regulations)
- Upon approval of a product, it allows **CE marking** so that the fertiliser can be **marketed and traded freely** throughout the EU, rather than approval and certification in each country.
- The new EU fertilizer regulation will be in force from **June/July 2022** - but after that it must be implemented in the national laws and executive orders on fertilisers

Thise projects have received funding from the European Union's Horizon 2020 research and innovation programme , grant agreements No.860127 (FertiCycle) and 818309 (LEX4BIO)

The new EU Fertilising Product Regulation

Central classifications:

CMCs = Component Material Categories:

New types of inputs covered

- CMC 1: Virgin material substances and mixtures
- CMC 2: Plants, plant parts or plant extracts (*processed plant mat.*)
- CMC 3: Composts
- CMC 4: Fresh crop digestate (*e.g. energy crops*)
- CMC 5: Digestate other than fresh crop digestate (*e.g. manure*)
- CMC 6: Food industry by-products
- CMC 7: Micro-organisms
- CMC 8: Agronomic additives
- CMC 9: Nutrient polymers
- CMC 10: Polymers other than nutrient polymers
- CMC 11: Derived products within the meaning of Regulation (EC) No 1069/2009 *(animal byproducts)*
- CMC 12: By-products within the meaning of Directive 2008/98/EC *(waste directive)*
- CMC13: Precipitated phosphate salts and derivatives (*e.g. struvite*)
- CMC14: Thermal oxidation materials and derivatives (*e.g. ash*)
- CMC15: Pyrolysis and gasification materials (*e.g biochar*)

Labelling Requirements and ***Conformity Assessment Procedures*** which varies between different CMCs and different PFCs

PFCs = Product Function Categories:

PFC1. Fertiliser

- A. Organic fertiliser
  - I. Solid organic fertiliser
  - II. Liquid organic fertiliser
- B. Organo-mineral fertiliser
  - I. Solid organo-mineral fertiliser
  - II. Liquid organo-mineral fertiliser
- C. Inorganic fertiliser
  - I. Inorganic macronutrient fertiliser
    - (a) Solid inorganic macronutrient fertiliser
      - (i) Straight or (ii) Compound solid inorg. macronutrient fertiliser
    - (b) Liquid inorganic macronutrient fertiliser
      - (i) Straight or (ii) Compound liquid inorg. macronutrient fertiliser
  - II. Inorganic micronutrient fertiliser
    - (a) Straight or (b) Compound inorganic micronutrient fertiliser

Traditional mineral fertilisers

PFC2. Liming material

PFC3. Soil improver

- A. Organic soil improver
- B. Inorganic soil improver

PFC4. Growing medium

PFC5. Inhibitor

- A. Nitrification inhibitor
- B. Denitrification inhibitor
- C. Urease inhibitor

PFC6. Plant biostimulant

- A. Microbial plant biostimulant
- B. Non-microbial plant biostimulant

PFC7. Fertilising product blend

Mixtures of any of the above

"New" types of product functions covered

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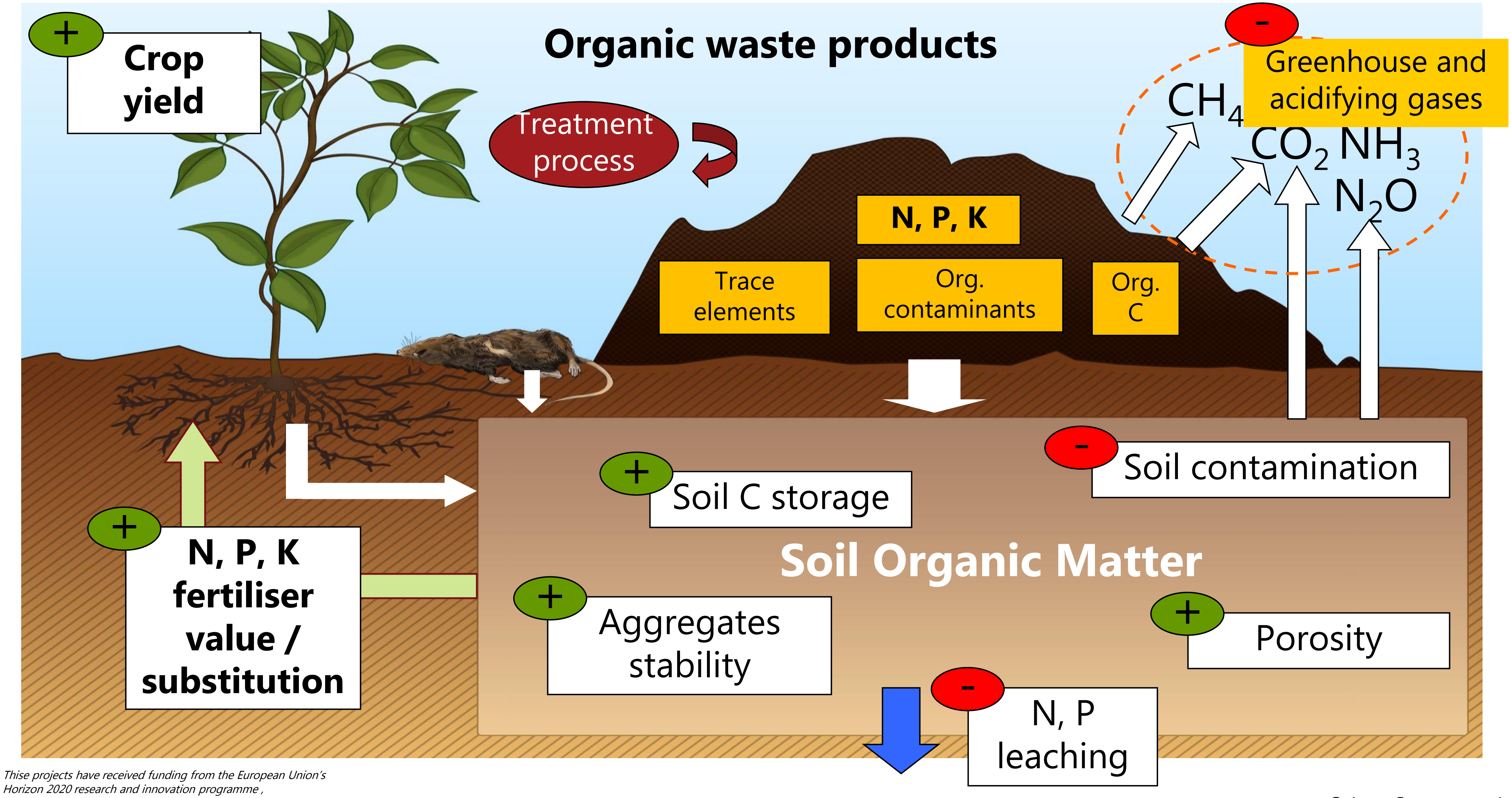
Bio-based fertilisers may have both positive & negative impacts



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LEX4BIO – Optimising bio-based fertilisers in agriculture

Providing a knowledge basis for new policies

Overall bjective: To decrease European dependency on finite and imported, apatite-based phosphorus and energy-intensive mineral nitrogen fertilisers.

Develop an evidence-base for the legislative framework for the optimised production and safe use of bio-based fertilisers (BBF) from nutrient rich side-streams (NRSS)

www.lex4bio.eu

PI: Kari Ylivainio
(LUKE, Finland)
2019-2024
21 partners
EU H2020
Budget 6 m€

Specific objectives include:

- **Mapping at local, regional and European scale the nutrient availability of NRSS to produce BBFs**, assessing their potential and identifying legal barriers and constraints
- **Identifying novel BBFs for crop production** and determining their effect on **soil quality**, **fertiliser value** and **crop growth**
- **Determining the risks** related to **food safety**, **human health** and **environmental losses** after application of BBFs and producing guiding principles for safe use of BBFs
- **Assessing the integrated ecological impacts** over the entire **lifecycle** of the production and use of BBFs
- **Determining the logistic costs**, **public perceptions** and **political actions required** for optimal use of BBFs

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818309 (LEX4BIO).

LEX4BIO activities

LEX4BIO work packages:
- WP1: **Mapping** resources and barriers for BBF
- WP2: BBF and **soil quality**
- WP3: BBF **agronomic P efficiency**
- WP4: BBF **agronomic N efficiency**
- WP5: BBF **contaminant risk** assessment
- WP6: BBF **LCA** - Life Cycle Assessment
- WP7: BBF **policy** framework & **socioeconomics**

In WP4 we focus on BBF agronomic N efficiency:
- Compliance methods for characterisation of N BBFs
  - Pot. N mineralisation, pot. ammonia loss
- BBF agronomic N efficiency and fertiliser replacement
  - Field trials across the EU
  - Satellite-based monitoring of BBF effects on crops
- Modelling of environmental N losses from BBF vs. mineral fertiliser

BBF selection
- We have screened the European market for commercially available BBF (in a region or country) in 2020
- In total about 40 N-based & 40 P-based BBFs selected
- Wide coverage of PFC/CMC criteria according to Fertilising Product Regulation
  - N-BBFs mainly CMC 3 – CMC 10 compost/digestate/ABP)
  - P-BBFs mainly CMC 10+ (ABP/precipitates/thermal prod.)

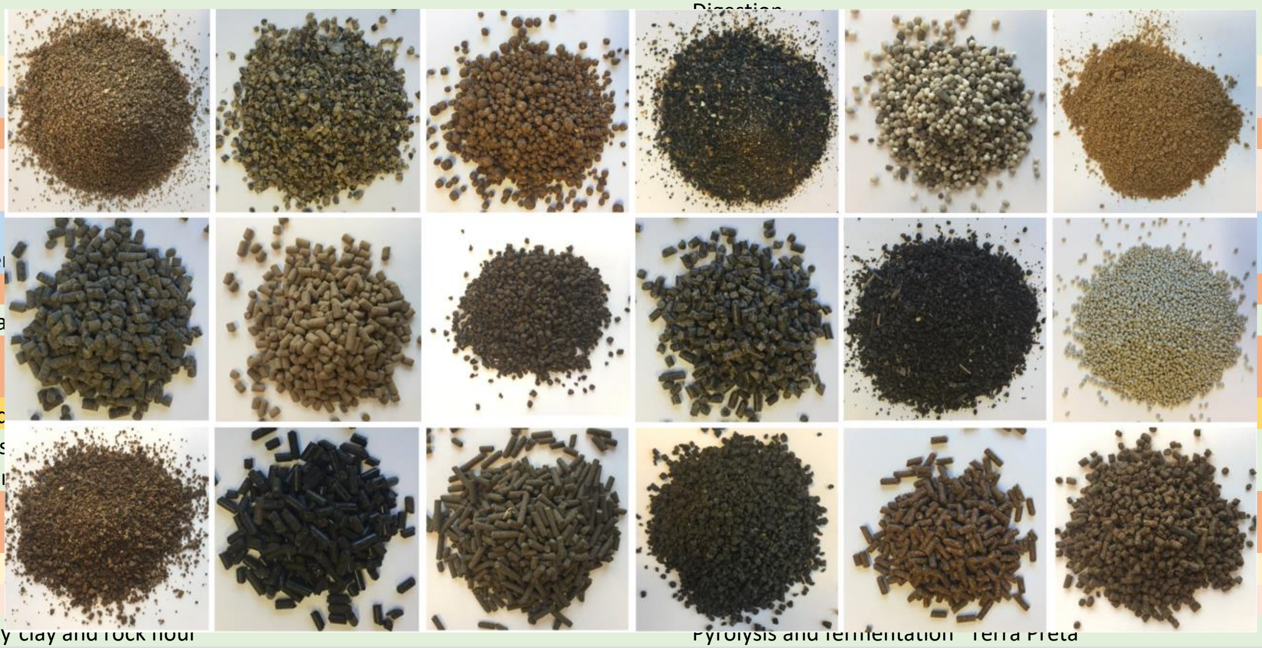
Selected BBFs from our longlist sorted by general PFC and major raw materials

PFC:		Compost	Fresh crop digestate	CMC: Food industry by-product+	Animal by-product	Recovered P-Salt	Ash	Biochar / pyrolysis product	
Organic fertiliser	Solid	5	3	5	9		1	4	27
	Liquid		1	5	1				7
Organo-mineral fertiliser	Solid	1	1	2	9				13
	Liquid			1					1
Inorganic fertiliser	Solid			1		13	5		19
	Liquid								0
		6	5	14	19	13	6	4	67

LEX4BIO N BBF list

ABP, dried poultry manure, plant-based, digestate, precipitates, mix, compost

	Raw material	Technology	PFC	CMC	BBF type
ASL	Product of nutrient-recycle-plant	Digestion	1 A-II	4	Mineral precipitate
AV4	Broiler litter	Drying, granulating and pelletising	1 A-I	10	Poultry manure
AV8	Broiler litter, blood meal and potassium sulphate	Drying, granulating and pelletising	1 B-I	10	Poultry manure
BA5	75 % BioAgenasol + 25 % wheat gluten	Fermentation and destillation	1 A-I	6/4	Plant based
BA6	Plant based residues (wheat and maize)	Fermentation and destillation	1 A-II	4/6	Plant based
BIH	Animal horns	Pelletising (Sphero technology)	1 A-I	10	Animal by-product
BIL	Broiler litter and seaweed	Drying and pelletising	1 A-I	10	Poultry manure
BIO	Meat and bone meal, apatite, vinasse, chicken manure and potassium sulphate	Pelletising	1 B-I	10	Animal by-product
BIP	Different plant watses, e.g. leftovers from sugar production	Liquid	1 A-II	6	Plant based
BLM	Blood meal			10	Animal by-product
BO1	Potato cell water	Evaporation	1 A-II	6	Plant based
BO2	Molasse	Digestion	1 A-11	6	Plant based
BO4	Vinasse (sugar production)		1 A-II	6	Plant based
BVC	Municipal organic food waste		1 A-I	3	Compost
CGR	Wastewater supernatant		1 C-I	13	Mineral precipitate
ECO	Blood and feather meal		1 B-I	10	Animal by-product
FEK	Chicken manure		1 A-I	10	Poultry manure
FEL	Chicken manure		1 A-I	10	Poultry manure
GRF	Manure and crop digestate		1 A-II	5	Digestate
HDG	75 % slurry, remaining mainly sepe		1 A-II	5	Digestate
ILF	Gelamin		1 A-II	10	Animal by-product
MAL	Mixture of malt germ, malt, minera		1 A-I	6	Plant based
MB2	Meat and bone meal		1 B-I	10	Animal by-product
MO13	Feather meal		1 A-I	10	Animal by-product
NAD	Liquid manure and vegetables resic		1 B-I	4	Mix animal and plant
NE4	Sugar, molassses, syrup, Aspergillus		1 A-I	6	Plant based
NE7	Plant-based organic raw material a		1 B-I	6	Plant based
OG1	Meat and bone meal		1 B-I	10	Animal by-product
OG2	Horn meal (pig bristles)		1 A-I	10	Animal by-product
OOC	Olive oil production residues		1 A-I	3	Compost
OPU	Chicken manure		1 B-I	10	Poultry manure
PAL	Fermented biochar and high-quality clay and rock flour	Pyrolysis and fermentation - Terra Preta	1 A-I	4	Plant based
PCS	Sewage water	P extraction via struvite	1 C-I	12	Mineral precipitate
PCW	Potato cell water	Evaporation	1 B-II	6	Plant based
PRI	Animal and/or vegetal origin + mineral granules	Compost into granules, then blending with mineral granules	1 B-I	3/6	Mix animal and plant
SDG	Agro and food waste + seaweed	Digestion	1 A-II	6	Digestate
SIF	Animal and vegetal raw materials	Granulating	1 A-I	6/10	Mix animal and plant
SYS	Ammonium-nitrogen and potassium	Digestion using reverse osmosis	1 C-II	6	Mineral precipitate
TRS	Fish soluble, 78 % proteins, 16 % ash	Enzymatic hydrolysis	1 A-I	10	Animal by-product
VEC	Residues of the digestion of horse manure	Composting	1 A-I	3	Compost



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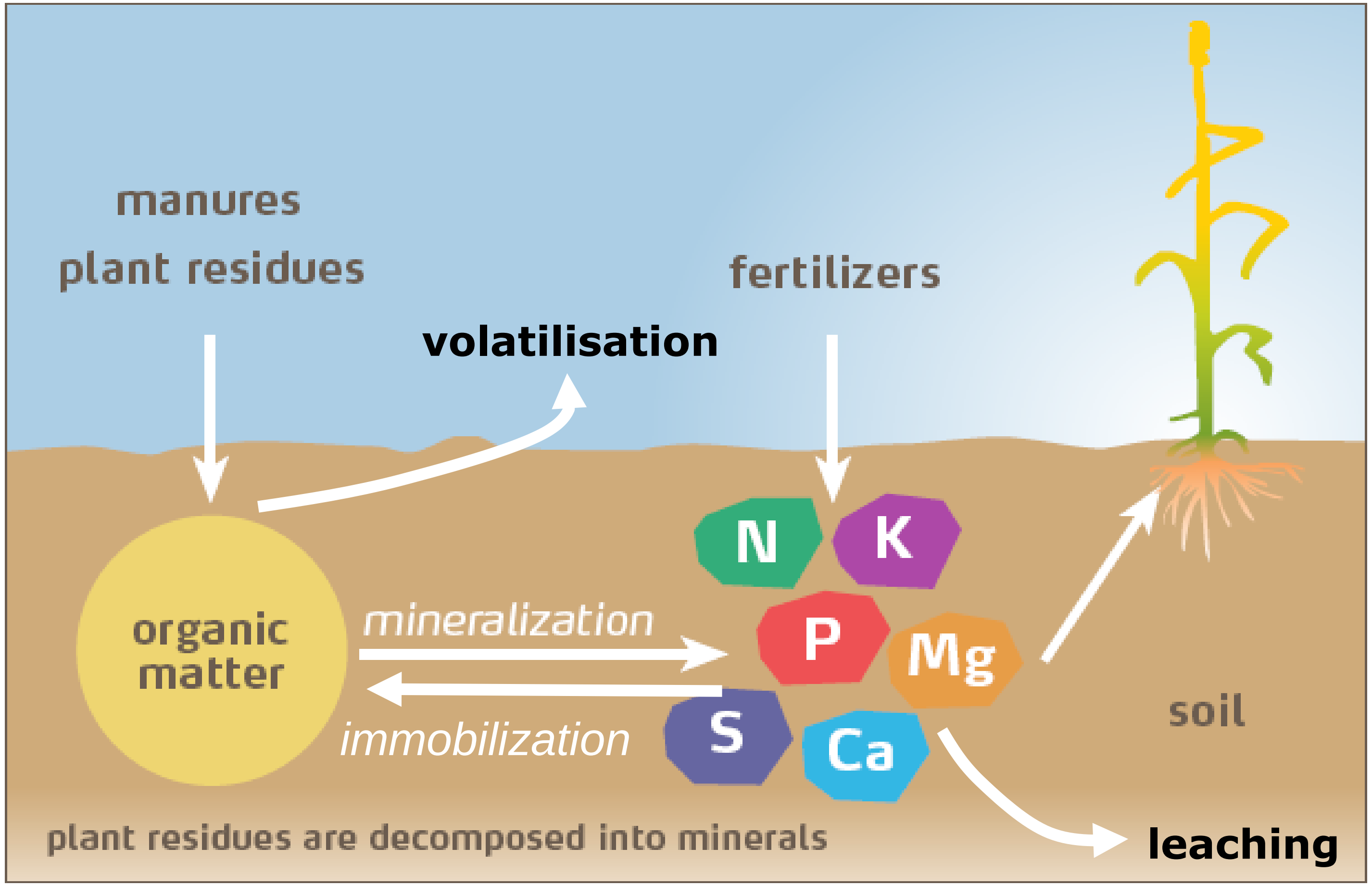
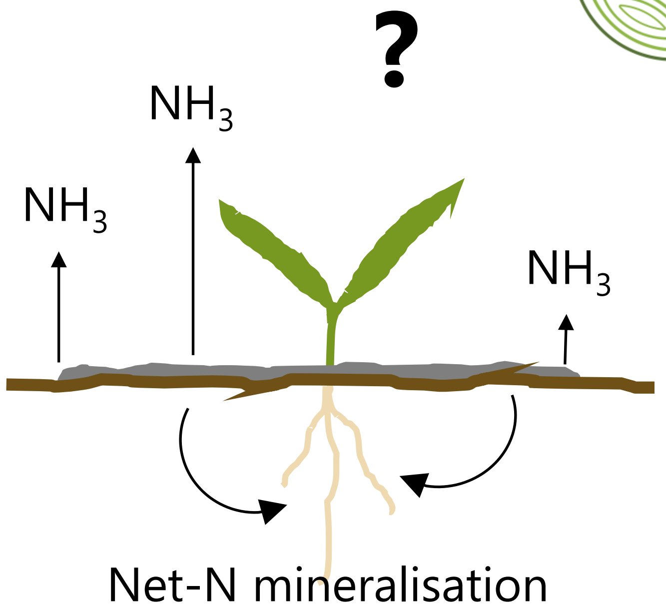
Challenges of bio-based vs. mineral fertilisers

How plants take up nutrients





Relevant N-BBF may have

- Higher risk of NH3 loss due to high pH or high carbonate content
- Slower N release / mineralisation

=

More unpredictable fertiliser value than mineral fertiliser

Thise projects have received funding from the European Union's Horizon 2020 research and innovation programme , grant agreements No.860127 (FertiCycle) and 818309 (LEX4BIO)

Develop and validate standard compliance methods for assessing plant N availability and fertiliser value

Potential N-mineralization of BBFs

Biological assays

- Aerobic nitrogen mineralization assay
- Cumulative soil respiration

Chemical extractions (mild)

- Hot water extractable N (HW-N)
- Hot KCl extractable N (hKCl-N)

Chemical extractions (moderate)

- Hot H_2SO_4 extractable N (H_2SO_4-N)
- $KMnO_4$ oxidizable N (POX-N)

Chemical extractions (stable)

- Index for residual organic carbon (IROC)

➢ *Correlations and predictions of potential N mineralisation*

Potential ammonia volatilisation of BBFs

Aerobic incubation with NH_3 and CO_2 traps

All longlist BBFs (39):

- Surface application
- Pure sand

Surface vs. incorporation (8 BBF):

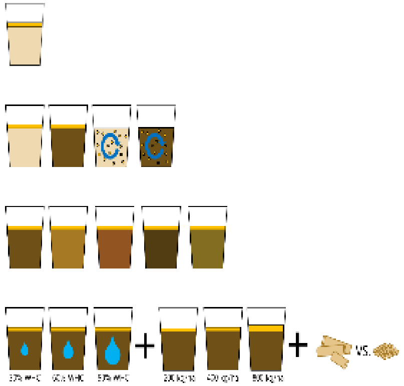
- Pure sand + sandy soil (DK)
- Surface vs incorporation

Field trial soils (5 BBF):

- 5 field site soils

Moisture, rate and form (3 BBF):

- Different soil moisture
- Different application rate
- Homogenization vs original form



➢ *Correlations and predictions of potential ammonia volatilisation*

= Combined predictions of potential plant N availability

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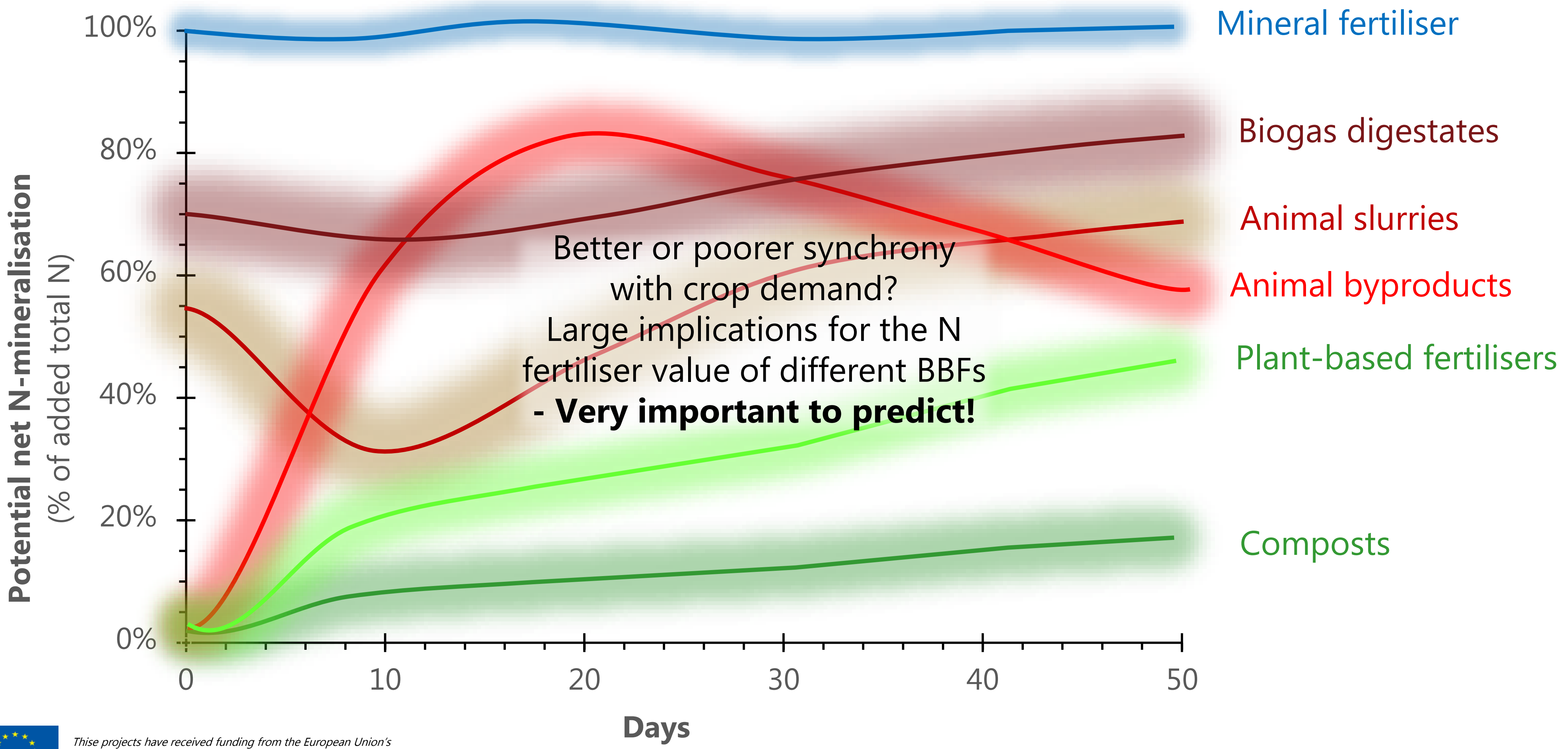
Potential N-mineralisation – mineral fertiliser vs. BBF

(Conceptual data – LEX4BIO results not finalised yet)



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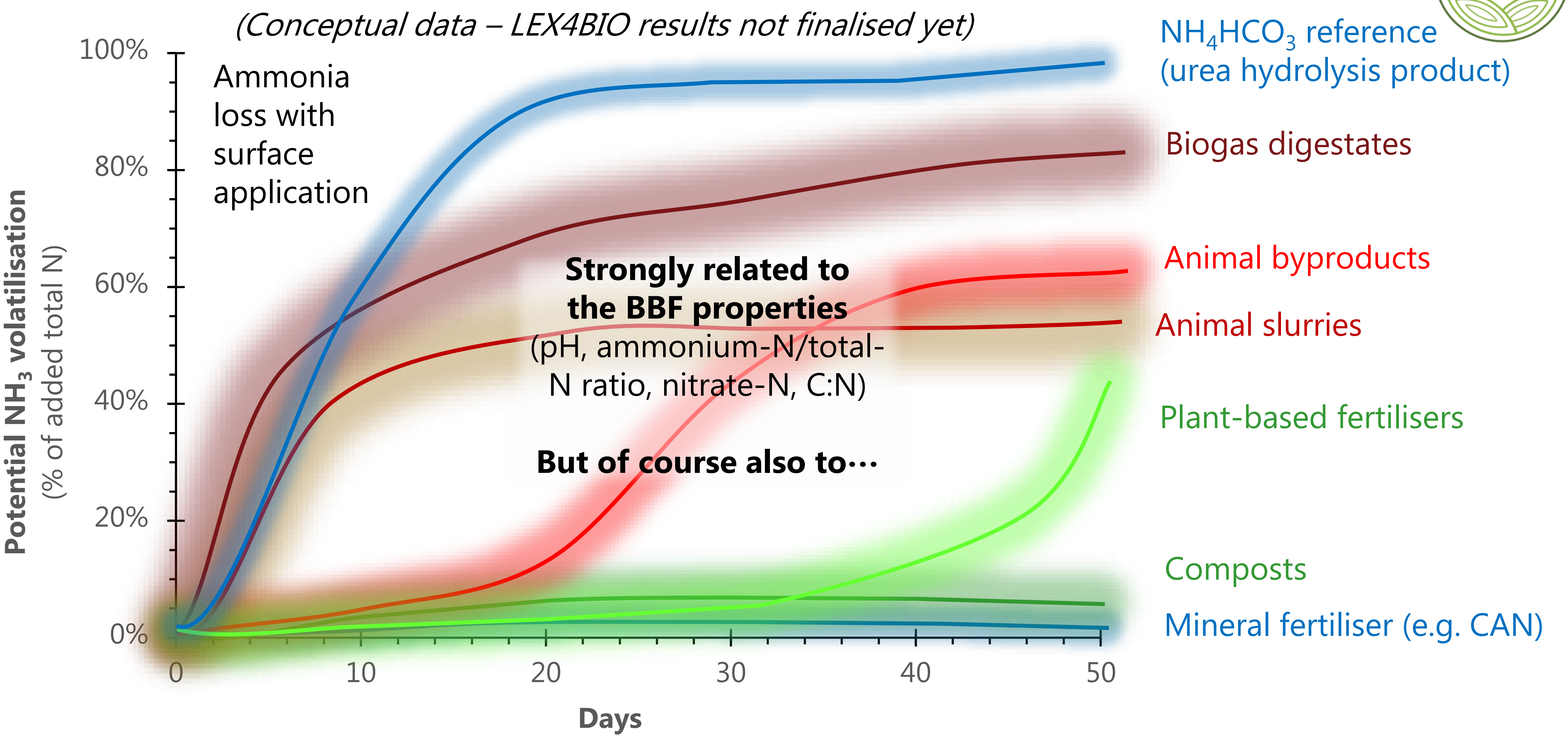
Potential ammonia volatilisation – min. fertiliser vs. BBF



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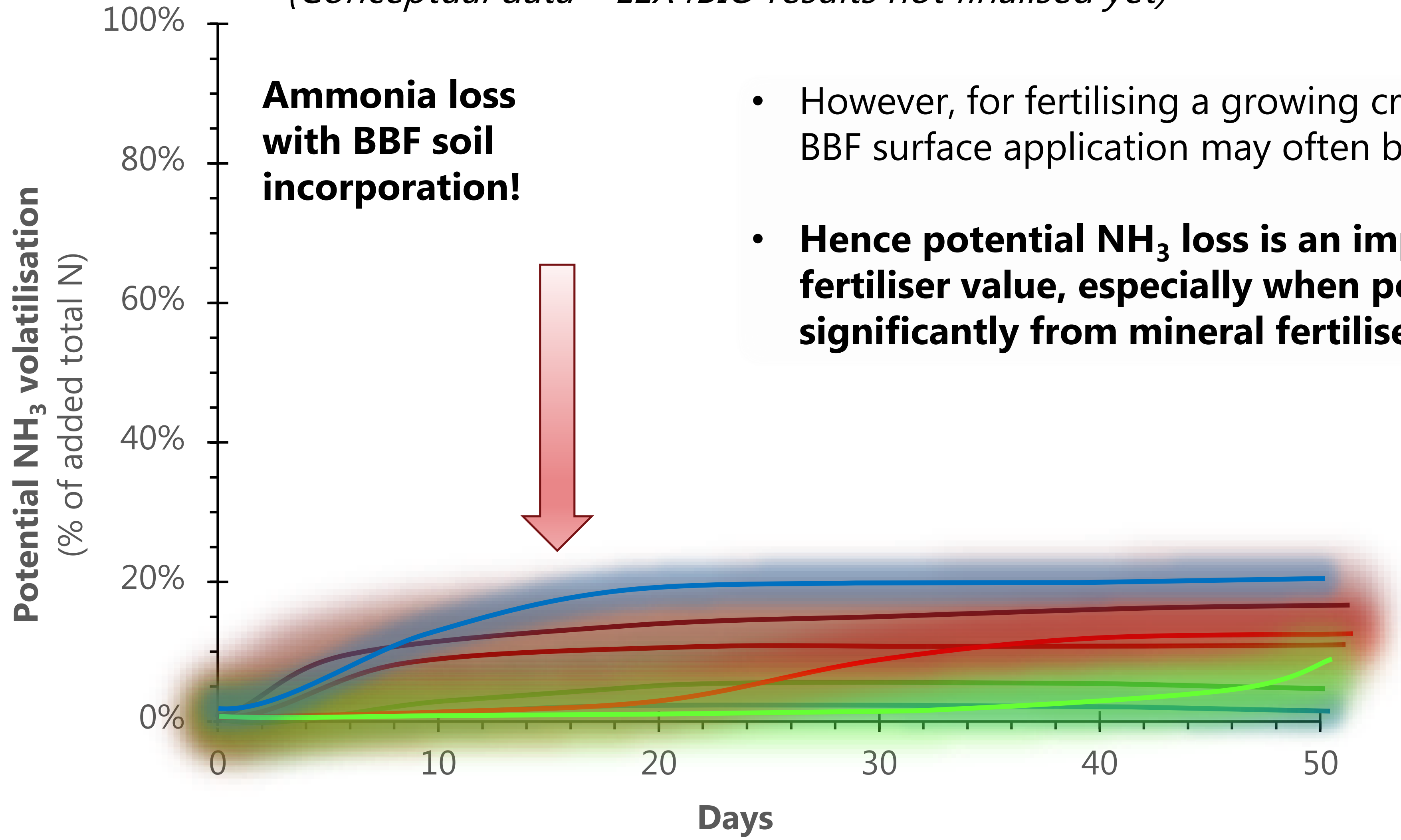
Potential ammonia volatilisation – min. fertiliser vs. BBF

(Conceptual data – LEX4BIO results not finalised yet)



- However, for fertilising a growing crop (e.g. a winter wheat), BBF surface application may often be the only realistic option
- **Hence potential NH_3 loss is an important predictor for fertiliser value, especially when potential loss differs significantly from mineral fertiliser**

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Testing actual agronomic N use efficiency & fertiliser value

LUKE (FI)

UCPH (DK)

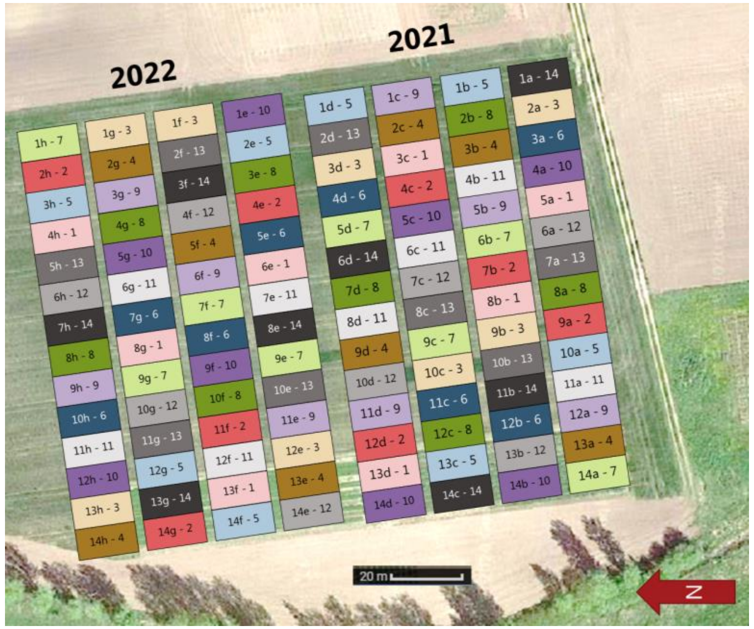
US (ES)

AII-RG (FR)

UHOH (DE)

1	BA6
2	PAL
3	FEK
4	MO13
5	ECO
6	OG2
7	BIO
8	SDG
9	BVC
10	PCW
11	Reference 1 - 0 kgN/ha
12	Reference 2 - 50 kgN/ha
13	Reference 3 - 100 kgN/ha
14	Reference 4 - 150 kgN/ha

- 5 field trials in a gradient (climate and soil types – FI to ES) + 2 validation sites (ZH, HU)
- 2-y field trials at each site
- Randomized block design (4 reps)
- 10 BBF + 4 min. refs
- Local typical spring/winter crops

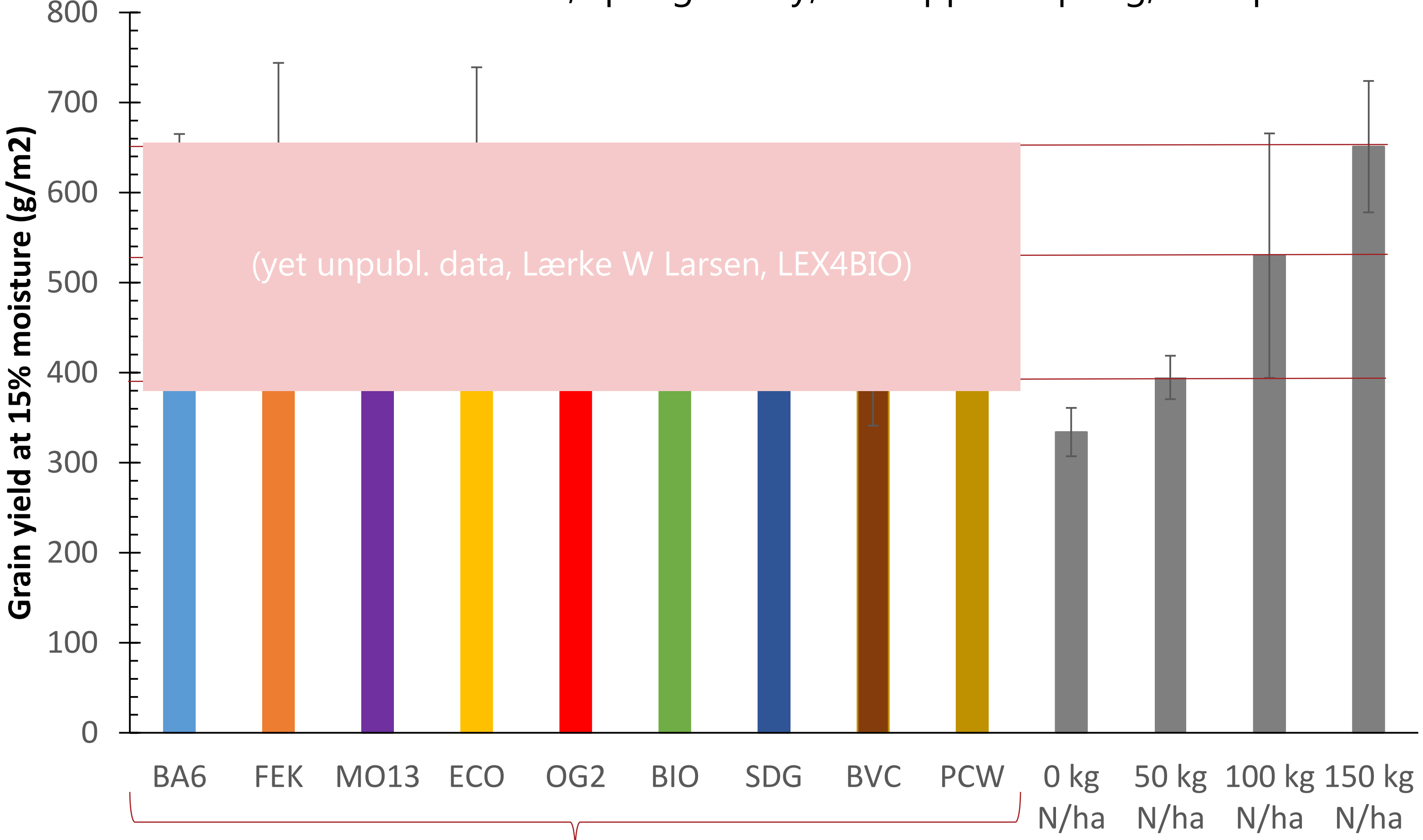


This projec[...] Horizon 20[...] grant agree[...] from the European Union's [...]n programme, [...]cle) and 818309 (LEX4BIO)

LEX4BIO

Example of yield results 2021

Field trial in Denmark, spring barley, BBF applied spring, incorporated



BBFs tested
Applied at 137 kg total-N/ha (recommended opt.)

Mineral fertiliser references (CAN)

NFRV of BBF
109%
73%
36%

Yield response of BBFs vs. mineral fertilisers

- Agronomic efficiency of N applied: AE= ΔYield/ ΔN
- N Fertiliser replace value, $NFRV_{BBF} = AE_{BBF}/Ae_{ref}$
- **Most of the BBFs showed a relatively high N fertiliser value (>70%)**

Thise projects have received funding from the European Union's Horizon 2020 research and innovation programme , grant agreements No.860127 (FertiCycle) and 818309 (LEX4BIO)

Training a new generation for the BBF challenge?

The FertiCycle network: New bio-based fertilisers from organic waste upcycling

Our vision

- To be able to **manage and process organic and nutrient containing waste streams** much more intelligently, not just by recycling, but by actually **upcycling** their content of **plant nutrients** and **organic matter**, to create new, more **valuable, bio-based fertilisers** with higher benefits.
- To base our approach on the **cradle-to-cradle** concept that all nutrient containing products can be upcycled in a **waste-free** and **circular economy**, where their entire **lifecycle** is considered and dealt with.
- **For this we need to train a new generation of bio-based fertiliser experts**

FertiCycle

European Training Networks (ETN) under Marie Sklodowska-Curie Actions in H2020 are an ideal engine for this!

We obtained a grant to initiate the FertiCycle network with 15 PhDs
PI: Lars Stoumann Jensen (UCPH, DK)

European Commission
Marie Skłodowska-Curie Actions

European Commission | Horizon 2020 European Union funding for Research & Innovation

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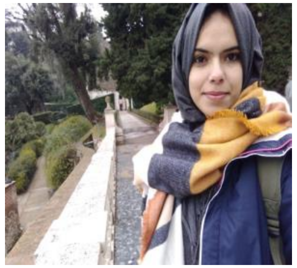
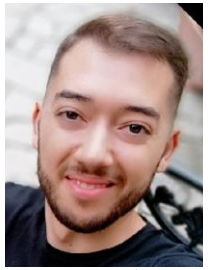
FertiCycle

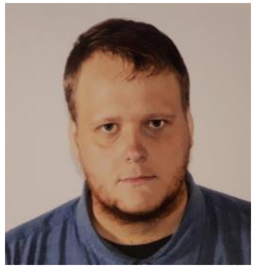
Recruitment of new bio-based fertiliser experts

15 Early Stage Researcher (ESR)


Jihane El Mahdi


Stamatis Chrysanthopoulos


Jared Nyang'au


Tomas Sitzmann


Hellen Luisa de Castro e Silva


Clara Kopp


Khan Wali


Mario Alvarez


Yusra Zireeni


Pietro Mendonca de Santis Sica


Florent Lelenda Kebalo


Maja Rydgård

Aslihan Ural


Egor Moshkin


Samaya El Hajj Hassan

We started the project 1 Jan 2020…

The COVID-19 pandemic hit us and the globe in March 2020…

In spite of pandemic obstacles we succeeded in recuiting these talented young PhD students from all over the world and relocating them to Europe by the end of 2020!

Thise projects have received funding from the European Union's Horizon 2020 research and innovation programme , grant agreements No.860127 (FertiCycle) and 818309 (LEX4BIO)

FertiCycle

Research + training + dissemination and expected outcomes of FertiCycle

WP8 Project management

Processing *Application* *Impacts*

Urban, Agricultural & Industrial Organic Waste

2020

15 Early Stage Researchers (ESR)

WP1 Organic modifications
Biosolids, manure, digestates, composts
ESR 1-3

WP2 Inorganic integrations
Concentrates, salts, ashes, biochars
ESR 4-6

WP3 Crop utilisation
fertiliser value, soil quality, emissions
ESR 7-10

WP4 Modelling impacts
Agronomy, environment, LCA
ESR 11-13

WP5 Markets
Economy, logi-stics, regulation
ESR 14-15

WP6 Scientific and complementary network training

WP7 Dissemination and Outreach

15 scientists trained to develop **sustainable fertiliser solutions**

High quality, **bio-based fertilisers**
New **markets**
Sustainable **environment**

Expected outcomes by end of 2023

2nd Virtual Winter School (2022)

Thise project ... Horizon 2020 research and innovation programme , grant agreements No.860127 (FertiCycle) and 818309 (LEX4BIO)

FertiCycle

Communication and dissemination


FertiCycle Newsletter 1
EU International Training Network

June 25, 2021

Introducing the FertiCycle ITN

Welcome to the FertiCycle International Training Network Newsletter! We will provide news and regular updates of research and developments in the FertiCycle Network. If you are not signed up for our newsletter, select here to visit our website and join the newsletter email list.

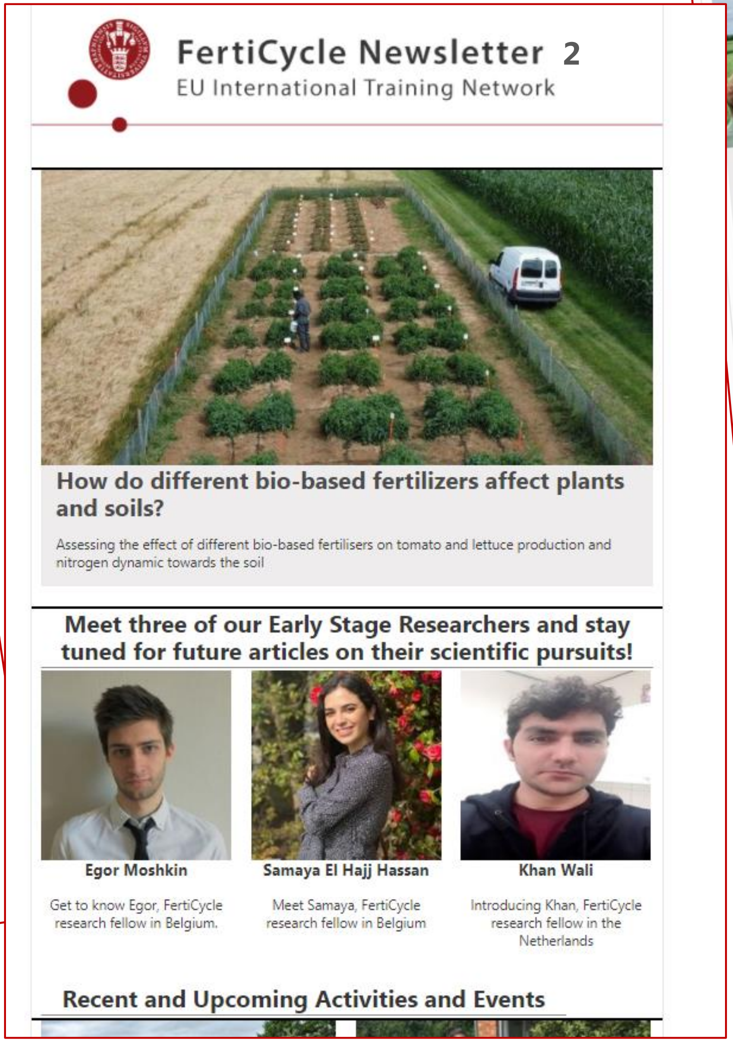
FertiCycle School is Open!!!

FertiCycle Overview

Watch Lars Stoumann Jensen, coordinator of FertiCycle, present an overview of the

An unusual beginning...

Learn how the FertiCycle Network navigated the Covid landscape here.


FertiCycle Newsletter 2
EU International Training Network

How do different bio-based fertilizers affect plants and soils?

Assessing the effect of different bio-based fertilisers on tomato and lettuce production and nitrogen dynamic towards the soil

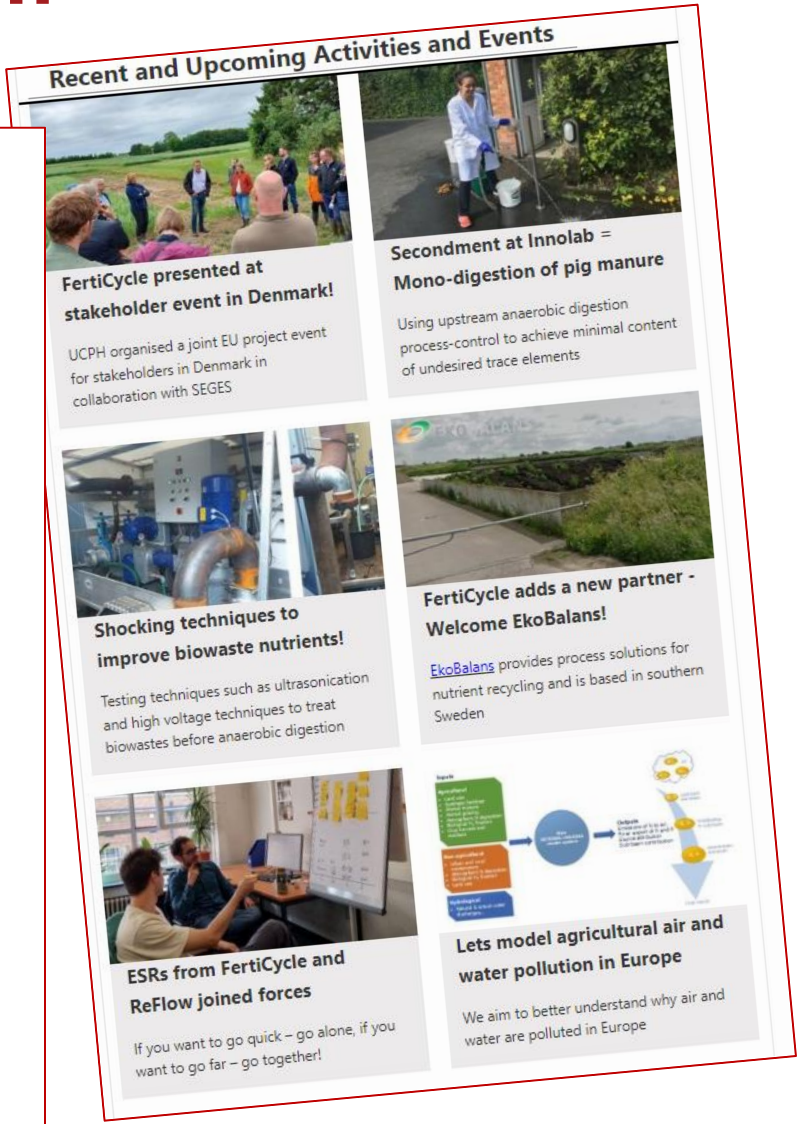
Meet three of our Early Stage Researchers and stay tuned for future articles on their scientific pursuits!

Egor Moshkin
Get to know Egor, FertiCycle research fellow in Belgium.

Samaya El Hajj Hassan
Meet Samaya, FertiCycle research fellow in Belgium

Khan Wali
Introducing Khan, FertiCycle research fellow in the Netherlands

Recent and Upcoming Activities and Events


Recent and Upcoming Activities and Events

FertiCycle presented at stakeholder event in Denmark!
UCPH organised a joint EU project event for stakeholders in Denmark in collaboration with SEGES

Secondment at Innolab = Mono-digestion of pig manure
Using upstream anaerobic digestion process-control to achieve minimal content of undesired trace elements

Shocking techniques to improve biowaste nutrients!
Testing techniques such as ultrasonication and high voltage techniques to treat biowastes before anaerobic digestion

FertiCycle adds a new partner - Welcome EkoBalans!
EkoBalans provides process solutions for nutrient recycling and is based in southern Sweden

ESRs from FertiCycle and ReFlow joined forces
If you want to go quick – go alone, if you want to go far – go together!

Lets model agricultural air and water pollution in Europe
We aim to better understand why air and water are polluted in Europe

Follow us: www.ferticycle.ku.dk where you can also sign up for our newsletter

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FertiCycle

New bio-based fertilisers from organic waste upcycling

10 beneficiaries & 7 partner organisations

ETH
BANGOR
INRAE
WAGENINGEN UNIVERSITY & RESEARCH
AARHUS UNIVERSITY
DISAFA
GHENT UNIVERSITY
INSTITUTO SUPERIOR DE AGRONOMIA
ADAS
Innolab
SCAM
fertilizers europe
AgroParisTech
EKOBALANS
nmi Soil for life

+ The FertiCycle approach

Market opportunities

Environmental impacts

Organic waste Streams:
- *Agricultural*
- *Urban*
- *Industrial*

Anaerobic digestion

Aerobic composting

Separation

Thermal treatment

Formulation

Soil quality

Plant nutrition

Utilisation & application

+ 15 FertiCycle ESR/PhDs

= Next generation scientists & high quality, bio-based fertilisers, a more sustainable environment and new markets!

Follow us: www.ferticycle.ku.dk, newsletter & SoMe

Thise projects have received funding from the European Union's Horizon 2020 research and innovation programme , grant agreements No.860127 (FertiCycle) and 818309 (LEX4BIO)

Thank you for your attention ! – I am open to any questions ☺

Contact: Prof. Lars Stoumann Jensen,
University of Copenhagen, Denmark
(lsj@plen.ku.dk)

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