



Norwegian Centre for Organic Agriculture



Stakeholders' perceptions about the applicability of bio-based fertilisers (BFF) in organic farming -the case of P

Anne-Kristin Løes, March 25, 2022

FertiCycle 2nd Winter-school: Nutrient cycling and environmental and agronomic impacts -
Sustainability of upcycled BBF production and use



What is a bio-based fertiliser (BBF)?

Lex4Bio: Bio-based fertilisers are produced from nutrient-rich side-streams (= organic waste)



Side-streams in agriculture, industry and society:

- Manure, forest residues, plant residues...
- Food industry waste
- Other industry waste (polymers, chars...)
- Sewage
- Organic household waste
- Green waste (gardens, parks..)



What is an **UPCYCLED** BBF?

Upcycle= to reuse (discarded objects or material)

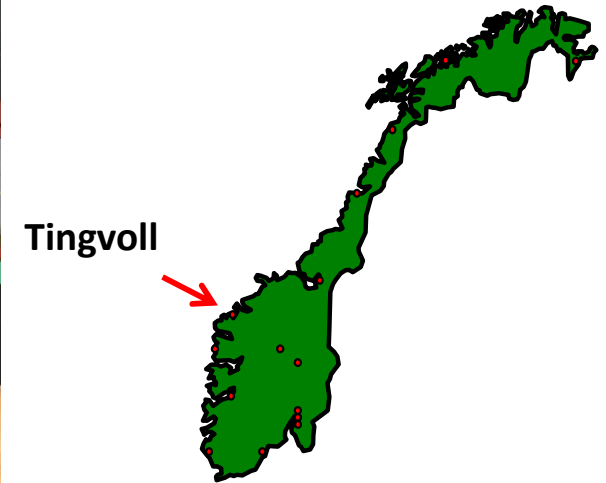
in such a way as to create a product

of **higher quality or value than the original** (Oxford Engl.Dict.)



Where do I come from?

Norwegian Centre for Organic Agriculture (NORSØK):
Hub for R&D in agronomy since 1986, location Tingvoll, NW Norway



Tingvoll farm - organically managed dairy production + experimental farm



22 dairy cows in loose housing

Biogas plant for cow manure, thermophilic process (to come)



Field experiments with BBFs



Exhibition centre & cafe

45 people working with agriculture and environment

Pathways to phase-out contentious inputs from organic agriculture in Europe (Organic-PLUS)

Case: animal-derived fertilisers from non-organic animal husbandry: manure, horn meal, hydrolysed animal proteins etc.

System approach in Organic-PLUS:

URBAN, VEGAN and RESID BBFs

- ✓ **Closing rural urban cycles** by using e.g., digestate from household waste (**URBAN**)
- ✓ Improving **internal nutrient cycles**, using **legume and non-legume plant materials (VEGAN)**
- ✓ Using residues from non-contentious sources like **organic food production** or **marine materials (RESID)**

Field experiments with alternative fertilisers in UK, Denmark, Germany, Norway



Organic-PLUS has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 774340



OUTLINE FOR TODAY (with a focus on organic agriculture)

- **Why do we need to replace mineral P with recycled P**
- **What are the possible sources of recycled P available to farmers**
- **What factors influence stakeholders' acceptance of recycled P, what are the limitations-based on the IMPROVE-P project**
- **What can be done to improve the uptake of BBFs among stakeholders? Government policies? Incentives?**

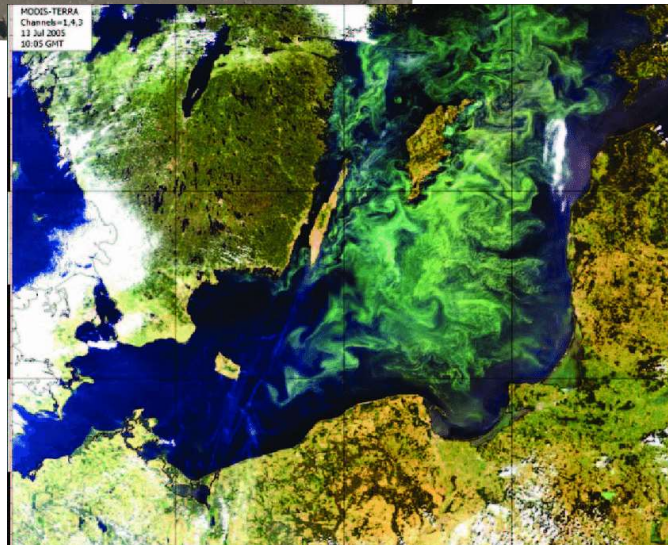
The list is not limited, and you can consider more factors.

Why replace mineral P with recycled?



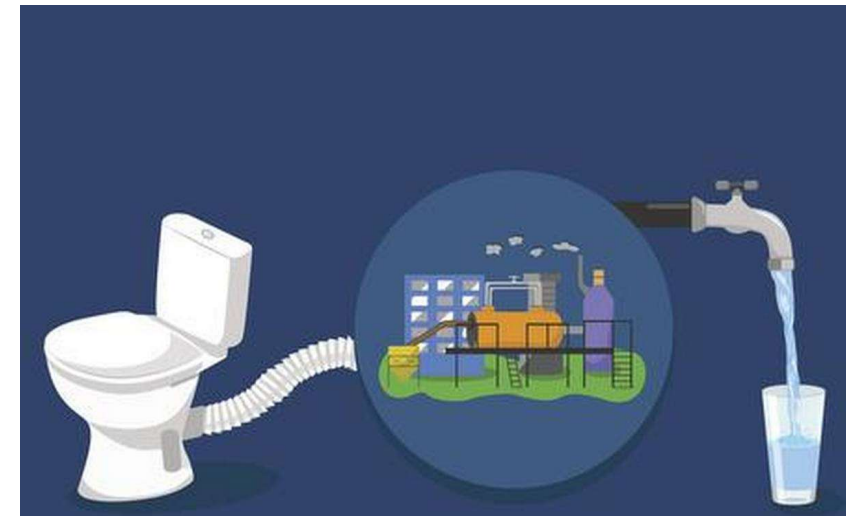
- Rock P is a scarce resource; Europe dependent on imports
- Mining of rock P causes significant environmental damage
- Rock P may be more required locally
- Production of triple super phosphate demands energy, resources, and causes local pollution
- Several reasons to utilise P in BBF!

Organic agriculture allows the use of rock phosphate, but in practice not extensively applied



Algae bloom in the Baltic Sea; July 13, 2005

https://www.google.com/search?q=algae+bloom+Baltic+sea&rlz=1C1CHBF_noNO990N0990&source=lnms&tbm=isch&sa=X&ved=2ahUKewjAnPTrldz2AhXIRvEDHfcdBLAQ_AUoAXoECAEQAw&biw=2048&bih=1009&dpr=1#imgrc=luyjAkQX3LgYQM



<https://www.thehindubusinessline.com/specials/india-file/waste-water-everywhere-recycle-it/article24436356.ece#>

What are the possible sources of recycled P available to (organic) farmers?

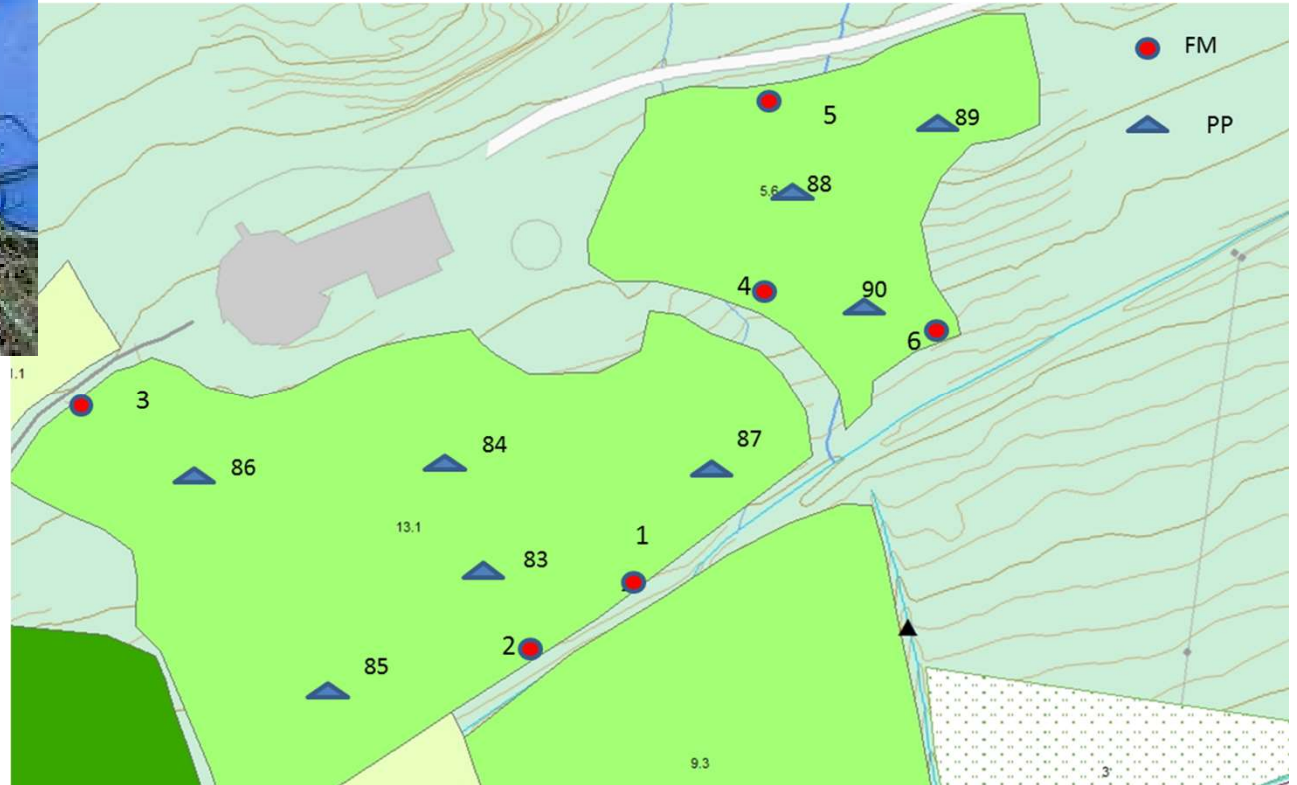
- Animal manure – in areas with high livestock density
- Processed animal manure (poultry; digestate)
- Sewage sludge/ashes – acceptability varies significantly between countries!
- Meat and bone meal: competes with application in feed (feeding increases P availability)
- Other animal-derived products: pig bristle, horn meal, hydrolysed animal proteins (hides)
- Compost and digestate from organic waste
- Source-separated human urine
- Struvite and calcined P (from thermal treatment of ashes + Mg)
- Lots of poorly utilised residual materials, e.g. from fish industry (aquaculture, fish capture, seaweeds)

Why should (organic) farmers apply P fertilisers?

Since 1989, regular soil sampling across 23 ha cultivated land + permanent pastures on Tingvoll farm



- Soil sampled from 0-20, or 0-20 + 20-40 cm soil depth
- 6 subsamples taken within 3 m from the fixed sampling point (PP) (sampling area ca. 30 m²)
- Sampling points identified by fixed landmarks (FM)

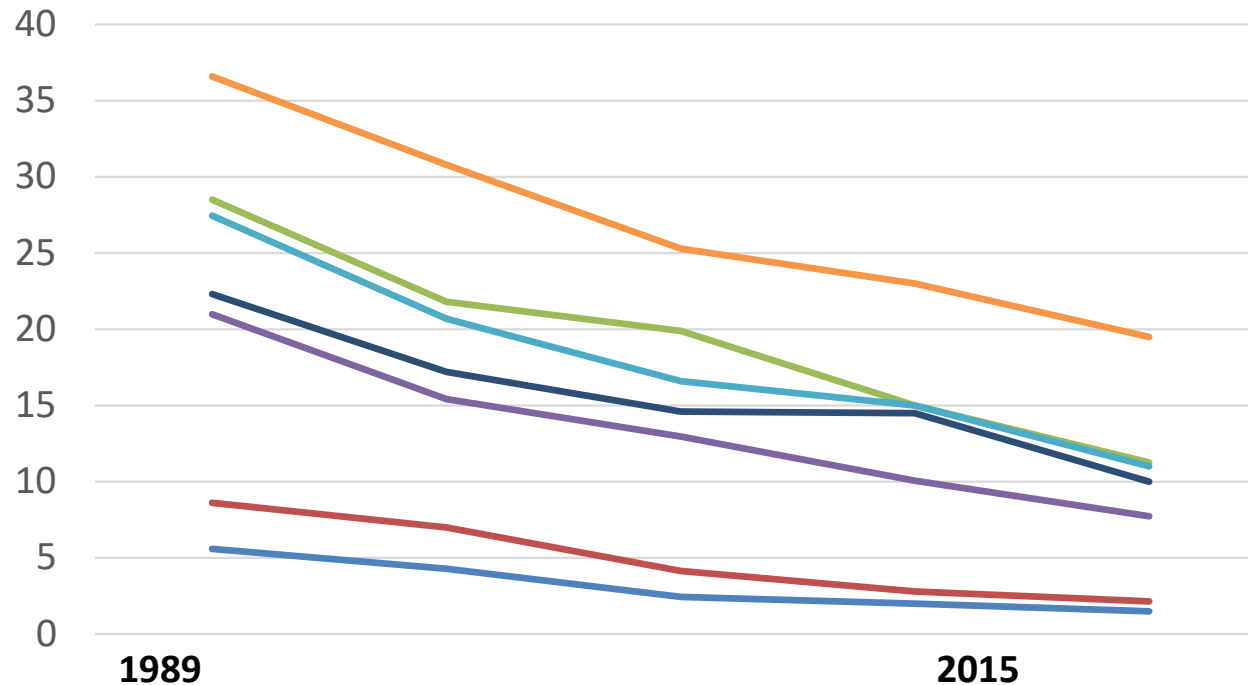


AL-extractable P in topsoil from Tingvoll farm 1989, 1995, 2002, 2009, 2015

mg P-AL /
100 mg air-dry soil

Average decrease 1989-2015:
From 20 to 10 mg P-AL/100 g (n= 16)

«Optimal»
level,
7 mg/100g:
Apply the
same
amount of
P as
removed
by yields



IMproved P Phosphorus Resource efficiency in Organic agriculture Via recycling and Enhanced biological mobilization (2013-2016)

Main outcomes

- A high proportion of organic farms have a very low and low available soil phosphorus (P) status
- Plant P availability of many recycled P fertilizers (RPFs) is higher than that of phosphate rock
- Potentially toxic elements (PTEs) are not the main constraint limiting nutrient recycling
- Many currently not permitted RPFs (e.g. struvite, digestates) have lower potential harmful effects on soils than permitted inputs (e.g. composts)
- Uncertainties on 'emerging' organic pollutants in RPFs and veterinary drugs in (conventional) manures remain, but current risk assessments of sewage sludge application indicate low risk to human health and the environment
- Approaches to reduce the risks from organic pollutants in RPFs have several shortcomings (e.g. losses of C, N and S, lower P recovery rates, increased energy inputs and GHG emissions)
- The inherent soil P mobilization potential is high in a biologically active soil
- There are significant differences in the acceptability of RPFs among countries

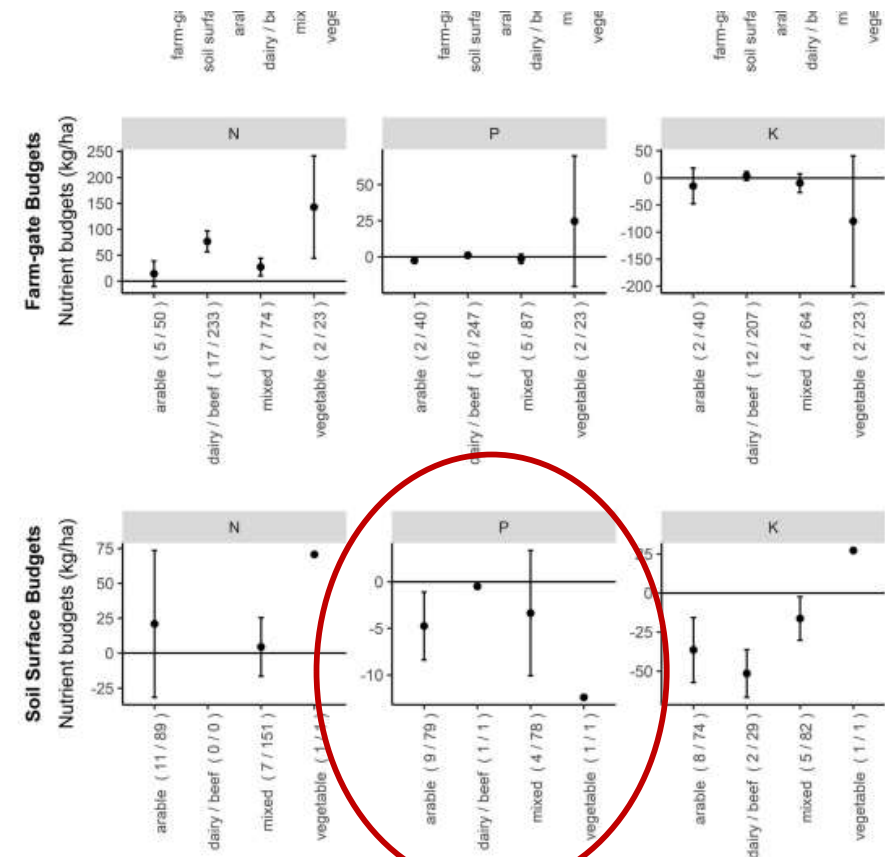


Fig. 1 Summary of the meta-analysis results of N, P, and K budgets as overall averages (top row), farm-gate budgets (middle row), and soil surface studies (bottom row). Dots represent the means derived from the meta-analysis in $\text{kg ha}^{-1} \text{ year}^{-1}$ and the bars the 95% confidence interval. The numbers behind the labels on the x-axis show the number of studies and investigated farms

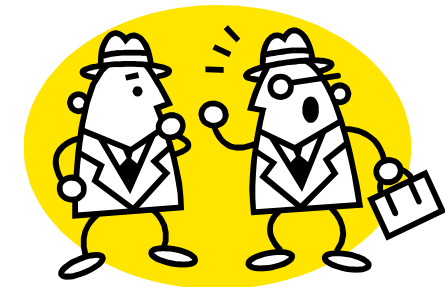
https://relacs-project.eu/wp-content/uploads/2020/06/Reimer_et_al_2020_meta_analysis_of_nutrient_budgets.pdf

What factors influence stakeholders' acceptance of recycled P? What are the limitations?



Improve-P WP4: Stakeholder perceptions about applicability of alternative P fertilizers in organic farming

Discussions with stakeholders about APF applicability, mainly by workshops in each of the participating countries



WP4 guiding statement:

The attitude of relevant stakeholders towards relevant APF (=BBF) may be changed during a discussion

where ethical and scientific arguments are assessed and balanced, making the stakeholders less negative to controversial fertilizers after the discussion



Residues of medical drugs, antibiotics, heavy metals, **pathogens**



Need for recycling;
utilise local resources;
maintain soil fertility;
keep P in the biosphere;
reduce dependency on
conventional agriculture

The workshop questionnaire (Q)

.. a tool to map the the participant's attitudes towards APFs

Facing up to the phosphorus challenge in organic farming *Some key facts and questions*



Many organic farmers use phosphorous fertilizers from off-farm sources. We refer to these as 'alternative P fertilizers'. There are many different sources of 'alternative P fertilizers', some are allowed under specific circumstances and others are currently not allowed. This questionnaire is to assess organic sector attitudes to a range of allowed and currently not allowed 'alternative P fertilizers'.

Conventional animal manure

Conventional animal manure (from high welfare and non GMO feed systems) is currently allowed, usually with a composting treatment. Several organic stakeholders argue that conventional manure should be banned due to risks of pesticide residues, GMO, animal welfare issues and the need for organic farming to be independent from conventional systems. However, many organic farmers are dependent on this input, and conventional manure is a good P resource.

Urban organic waste

Waste from food production and consumption, as well as waste from gardens and recreational areas, contain significant amounts of P. When such waste is treated e.g. in compost plants or by anaerobic digestion it is sanitised and stabilised. Currently, only compost or digestate exclusively derived from specific slaughter wastes ('meat and bone meal'), recreational areas ('green waste') and/or sorted household waste is allowed in organic farming, which significantly limits the use of urban waste P. Catering food wastes, animal manure from factory farming and sewage sludge are potential further sources of substrate for compost and AD plants.

Human "manure"

Human urine and faeces, currently banned in organic farming, contain significant amounts of P and organic matter, but also may contain pathogens, heavy metals, pharmaceuticals and toxic residues. During treatment, various chemicals may be added e.g. to facilitate dewatering or precipitation.

Questionnaire to assess stakeholders' opinions about P fertilization in organic farming, as a part of the Improve-P project

In which country do you work?Gender:Age:Profession (please tick or circle a)

Farmer/producer Advisor Certification sector Scientist Business sector Other, please specify:



Nine workshops 2014-2016, **two international**, two in Germany



IFOAM OWC, Istanbul, October 2014

Solihull, GB November 2014

Totally 213 Qs filled in

Biofach, DE February 2015

WiTa, DE March 2015

Organic 3.0, NO November 2015

Expert Day on P in OF, CH, November 2015

National Organic Congress, DK, November 2015

BioAustria Tagung, AT, January 2016

Bioland Tagung, DE, January 2016

Compiled

Workshop content

- Experts described the need for P input to organic farming
- Experts described pros and cons related to different permitted and currently non-permitted fertilizers
- Stakeholders discussed
- Stakeholders filled in questionnaires (Qs) to record the acceptability of different recycled fertilizers in organic farming, permitted and not permitted by EU regulations



Structure of Qs:

Fertilizers were grouped into

- Conventional animal manure (different animals)
- Urban waste products (green waste, household, catering, animal residues included or not)
- Products originating from human waste (precipitated, sludge, ashes)
- Other products (rock P, MBM..)

Who were the stakeholders?

- Aged 15 – 81 years, average 44
- 62 % male, 38 % female
- 38 % farmer, producer, grower (mostly male)
- 23 % scientist (many female)
- 11 % advisor (mostly female)
- 28 % other (certification, student, NGO, information officer...)



Results published in Løes et al 2016,
orgprints.org/id/eprint/30368/

The workshop made most stakeholders more positive



Do you think that your opinions about P fertilization in organic farming have changed after attending the Improve-P workshop and answering these questions?

- The workshop did not have any impact
- The workshop made me more positive about the use of recycled P fertilizers in organic farming
- The workshop made me more sceptical about the use of recycled P fertilizers in organic farming

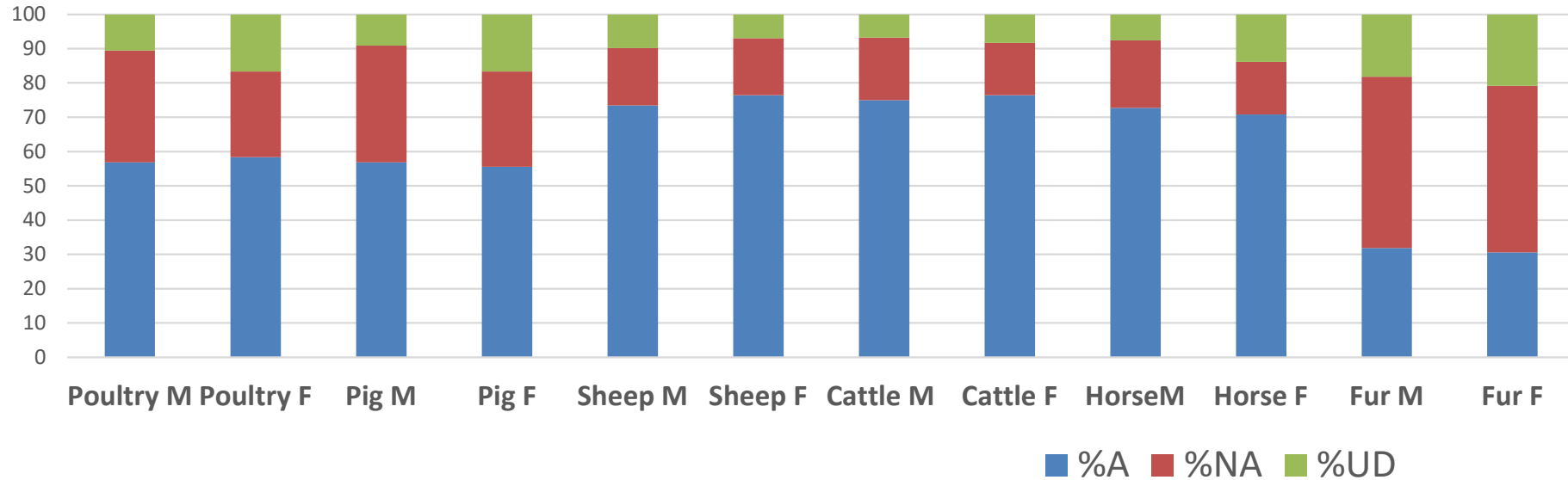
Generally, very small effects of gender

Gender	No answer	No impact	More positive	More negative
Female (n=72)	18	32	46	4
Male (n=132)	18	24	48	9

Farmers generally more sceptical than scientists and advisors

No info about gender n= 9

Sheep, cattle and horse manure preferred over pig, poultry and fur animals



For conventional manure in OF, stakeholders preferred manure from ruminants and horses, across gender

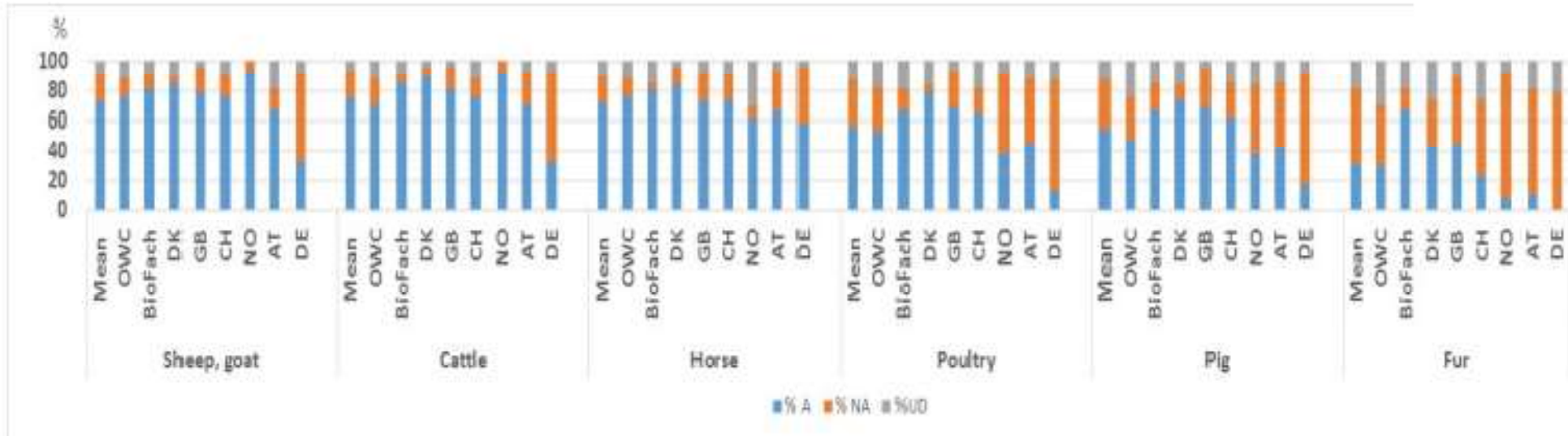
A = acceptable, NA = not acceptable, UD = undecided

Small effects of gender; F slightly more often undecided, and slightly more sceptical to pig and poultry manure

TYPES OF ANIMAL MANURE

German stakeholders: generally sceptical

Danish: surprisingly positive?



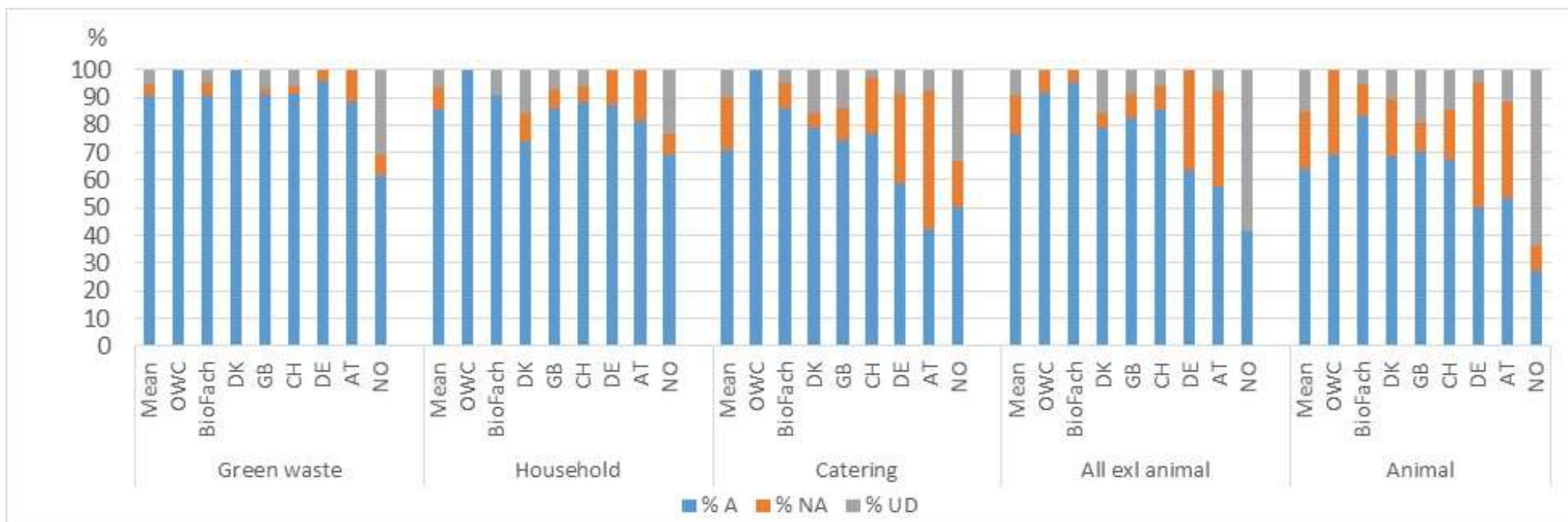
Personal comments: Most concern raised about contents of pesticides, drugs, potentially toxic elements (Zn, Cu) + management intensity; integrity hardly mentioned; totally avoid animal production mentioned by some

But: «Banning animal manure makes the organic sector look ridiculous...»

RECYCLED ORGANIC WASTE: GREEN PREFERRED



German + Austrian stakeholders agree, most sceptical. Swiss differ from DE, AT!
 Danish + English most positive



Proportions of stakeholders in each workshop regarding different types of recycled organic waste (composted or anaerobically digested) as A or NA within organic farming standards, or being UD, arranged with decreasing level of acceptance. Green waste = from recreation areas; Household = source separated household food waste; Catering= food waste from institutions, restaurants, trade etc.; All excl. animal = food waste from food processing industry, excluding animal products; Animal = food waste from animal products e.g., abattoir (slaughter waste)

HUMAN WASTE: URINE OK

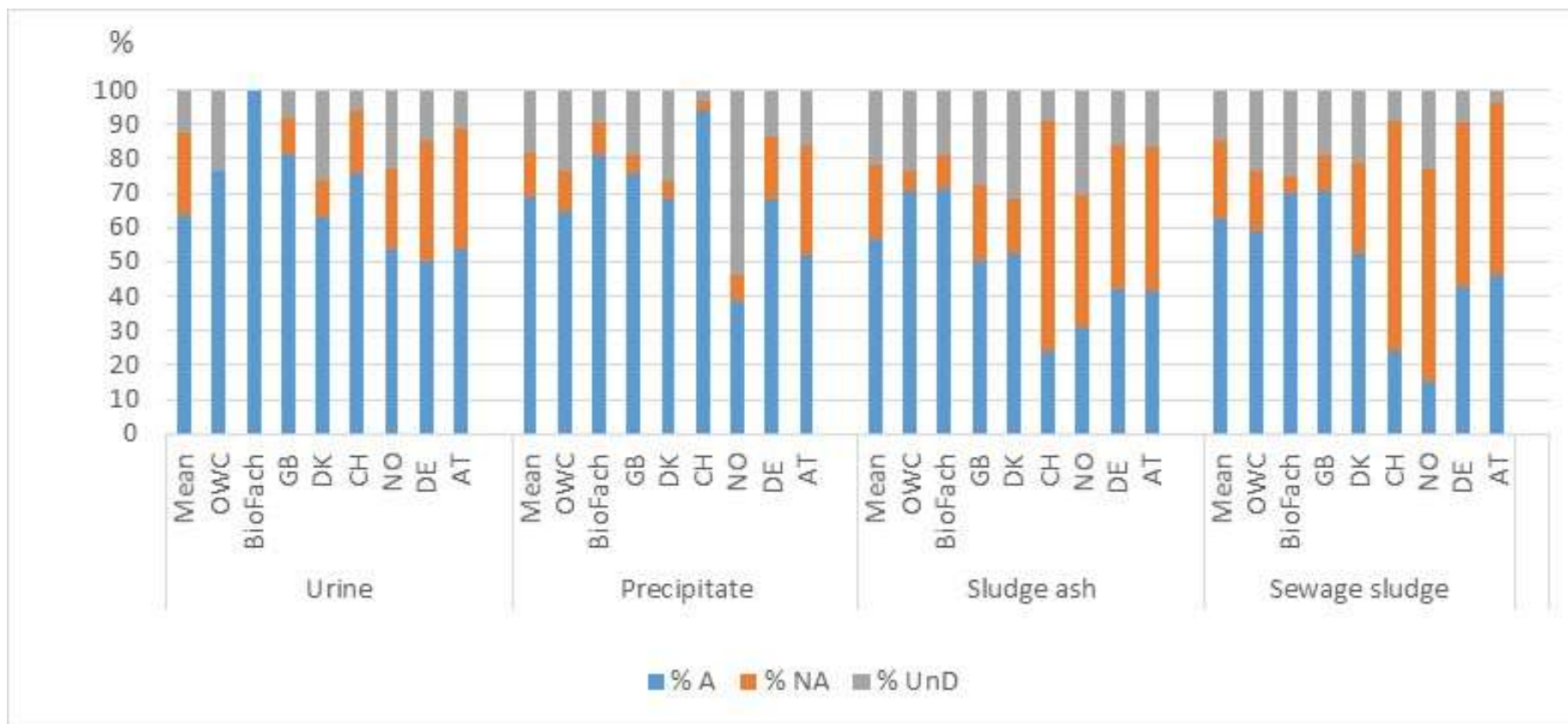
Again most scepticism in DE, AT, especially for sludge
 Swiss strong scepticism to sludge, very positive to struvite
 GB, DK quite positive



**How To
Use Pee
In Your
Garden**

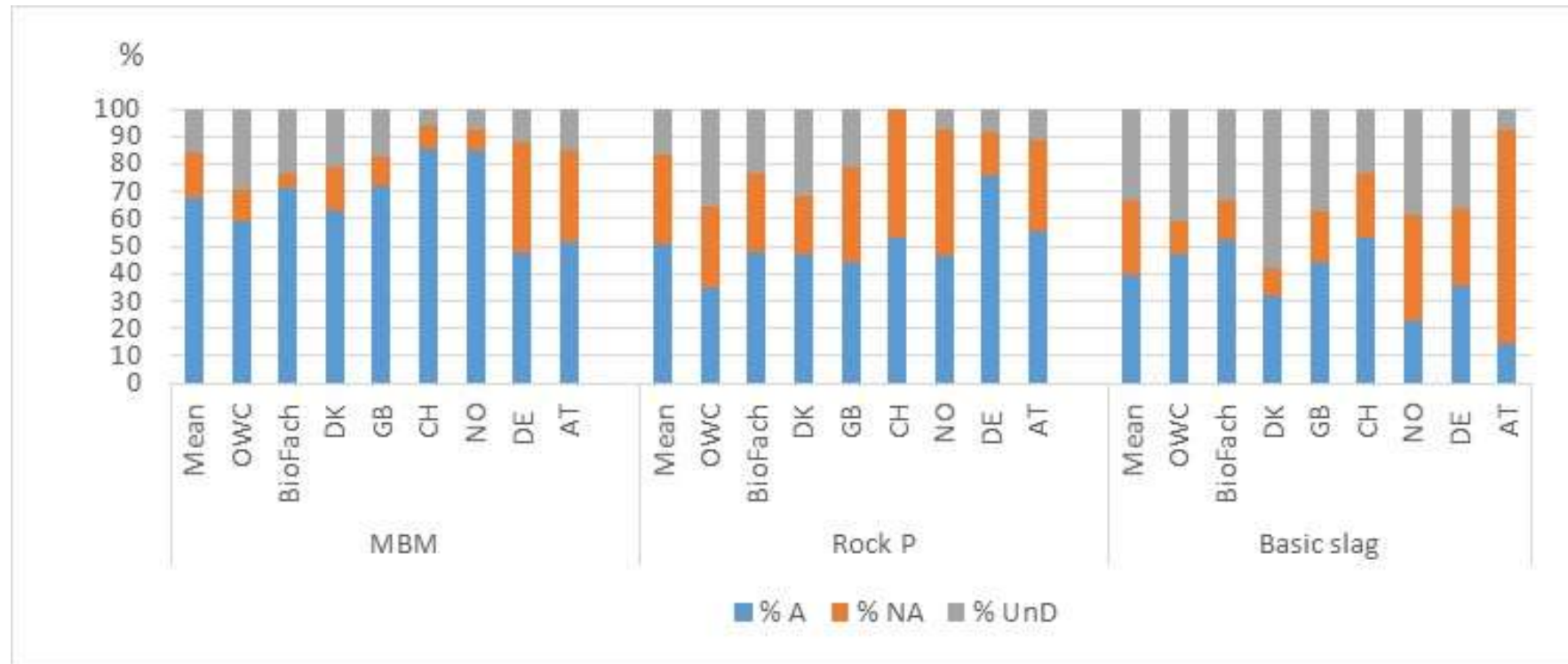


THEWEDIBLE.COM



Personal comment from UK: "I think there is a lot of waste organic matter that could be put to good use. Indeed, it is very important that it does. However, it may be used as another stick to berate (punish) the organic brigade; branding them as eccentrics that fertilize their crops with wee"

OTHER ALTERNATIVES: MBM > ROCK P > SLAG



Personal comment from Biofach: "Meat and bone meal (MBM) feels disgusting, but it's certainly needed to close the big cycle"

Average acceptance for fertilizer products and substrates for composting or anaerobic digestion



Type of fertilizer product or substrate	% Acceptability by all stakeholders (average value)
Green waste (from recreational areas)	91
Source separated household waste	85
Food industry residues excluding animal residues	77
Conventional cattle manure	75
Conventional sheep and goat manure	73
Conventional horse manure	72
Meat and bone meal	72
Catering food waste	71
Precipitated P from human excreta	69
Food industry residues including animal residues	64
Human urine	64
Sewage sludge	63
Ashes from incinerated sewage sludge	56
Conventional poultry manure	56
Conventional pig manure	55
Rock P: 54%	54
Basic slag: 43 %	43
Conventional manure from fur animals	31

What can be done to improve the uptake of BBFs among stakeholders?

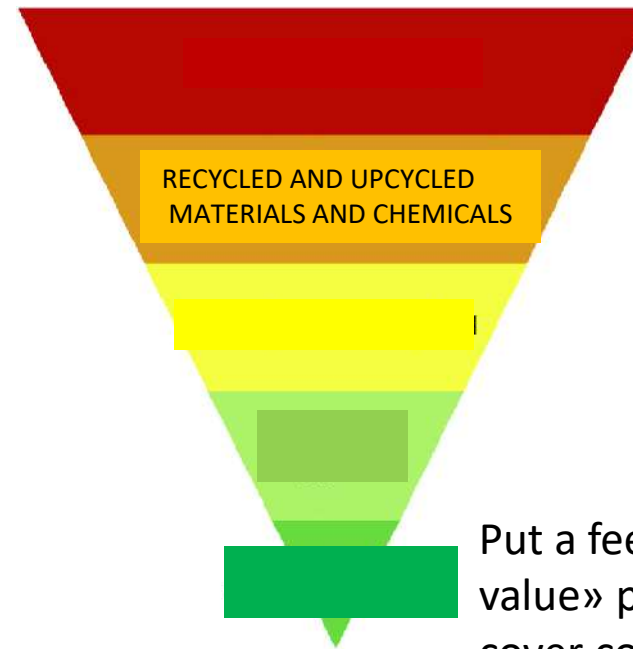
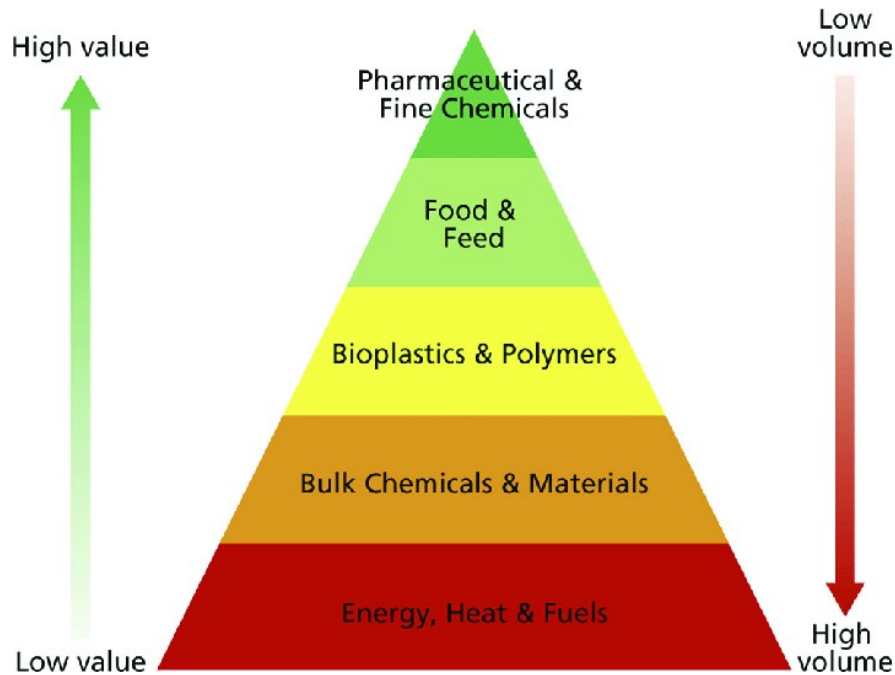
- Maintain high prices on conventional fertilisers and expand sanction policies to more exporting countries who do not respect human rights
- Fulfill ambitious goals in EU F2F strategy of 25% organic area by 2030
- Improve regulations (e.g. organic standards) to support utilisation of more materials: *«Organic farmers are subject to substantial variation in standards arising from the interpretation of EU regulations into national laws, restrictions imposed by private actors such as retailers, and private standards which may be stricter than EU regulations. In several countries, the majority of organic farmers are certified by private, stricter standards. We propose that EU regulations and private standards for organic production should not limit the use of recycled fertilizers in organic farming systems, as long as means are taken to ensure the quality and safety of these inputs. Awareness of the need to close nutrient cycles may contribute to adapting regulations and private standards to support recycling of nutrients from society to organic agriculture. A better definition of the term “natural substance” in organic regulations is required.»*

Løes et al 2016 : orgprints.org/id/eprint/30522

- For farmers in general, emphasise potential to benefit soil health, capture C, contribute to SDGs?



Funding bodies for R & I should turn the value pyramid upside down!



Put a fee on «high-value» products to cover costs for a complete utilisation!

Then you can all be employed in the dozens of new and innovative fertiliser factories across Europe (and elsewhere)





www.norsok.no