

Nutrient value of digestates

Martin N Hansen

Senior Consultant. Ph.d.

Plant & Environments, SEGES Innovation

Promilleafgiftsfonden for landbrug



Meeting with South African biogas group 07-09-2023 at SEGES

SEGES
INNOVATION

Biogas have several important effects!

1. Green energy – independence of natural gas
2. Reduced climatic impact
3. Recycling of organic waste products
4. Possible lower environmental impact
5. Possible improved nutrient value



...all of those are very important political and social agendas!

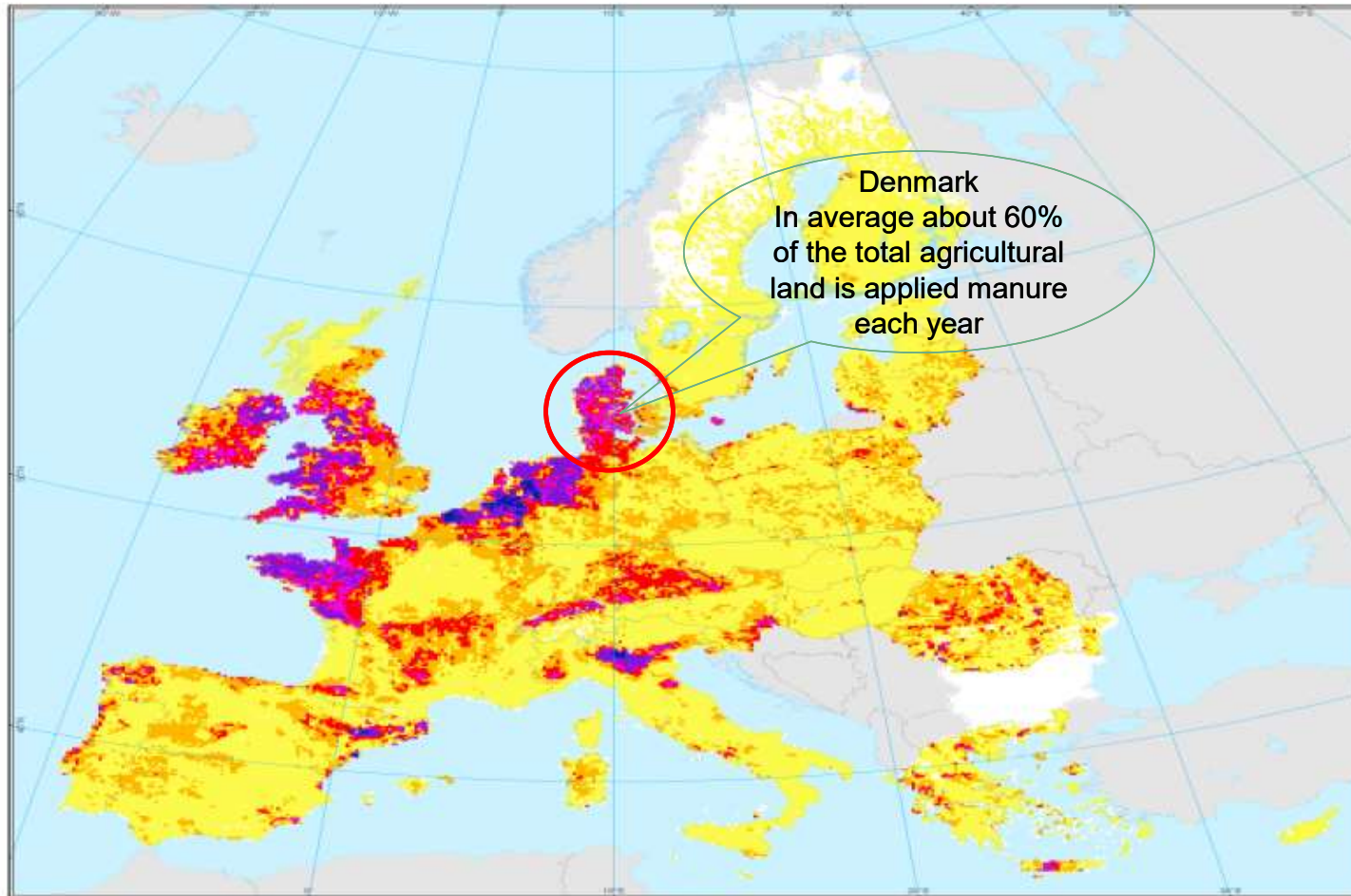
Biogas have several important effects!

1. Green energy – independence of natural gas
2. Reduced climatic impact
3. Recycling of organic waste products
4. Possible lower environmental impact
- 5. Possible improved nutrient value**

...all of those are very important political and social agendas!

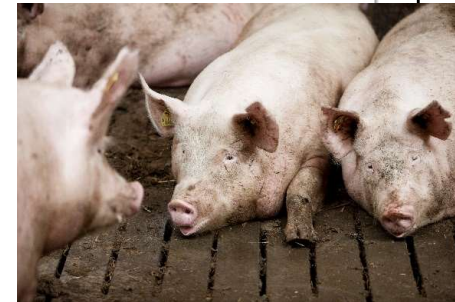


Denmark has a very high manure production, and manure is a very important fertiliser



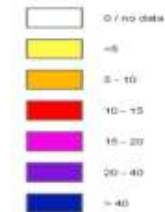
EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre
MANURE PHOSPHORUS FERTILISER

ies
Institute for
Environment and
Sustainability



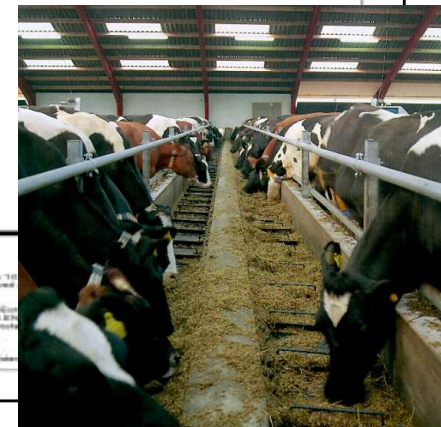
Manure Phosphorus Fertiliser

(kg P/ha)



Manure P fertiliser application calculated for a 10 km x 10 km grid. For the 10 new member states manure data was derived from the University of Bonn.

Source: JRC (Mulligan et al. 2008). An Atlas of European Agriculture in Territorial Context. EUR 23334 EN. Coordinate Reference System: ETRS89 Lambert Azimuth Equal Area. JRC 023007. © EuroGeographics for the administrative boundaries. © 2007 Copyright, JRC, European Commission. Extracted from GISS, (European Land Information System).



Optimal utilisation of manure =
- optimal recirculation of nutrients
- reduction of loss and environmental impact



SEGES
INNOVATION

Optimal utilisation of manure =
- optimal recirculation of nutrients
- reduction of loss and environmental impact

Biogas production has become more and more important



Other organic biomasses



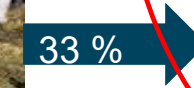
**Biogas
production**



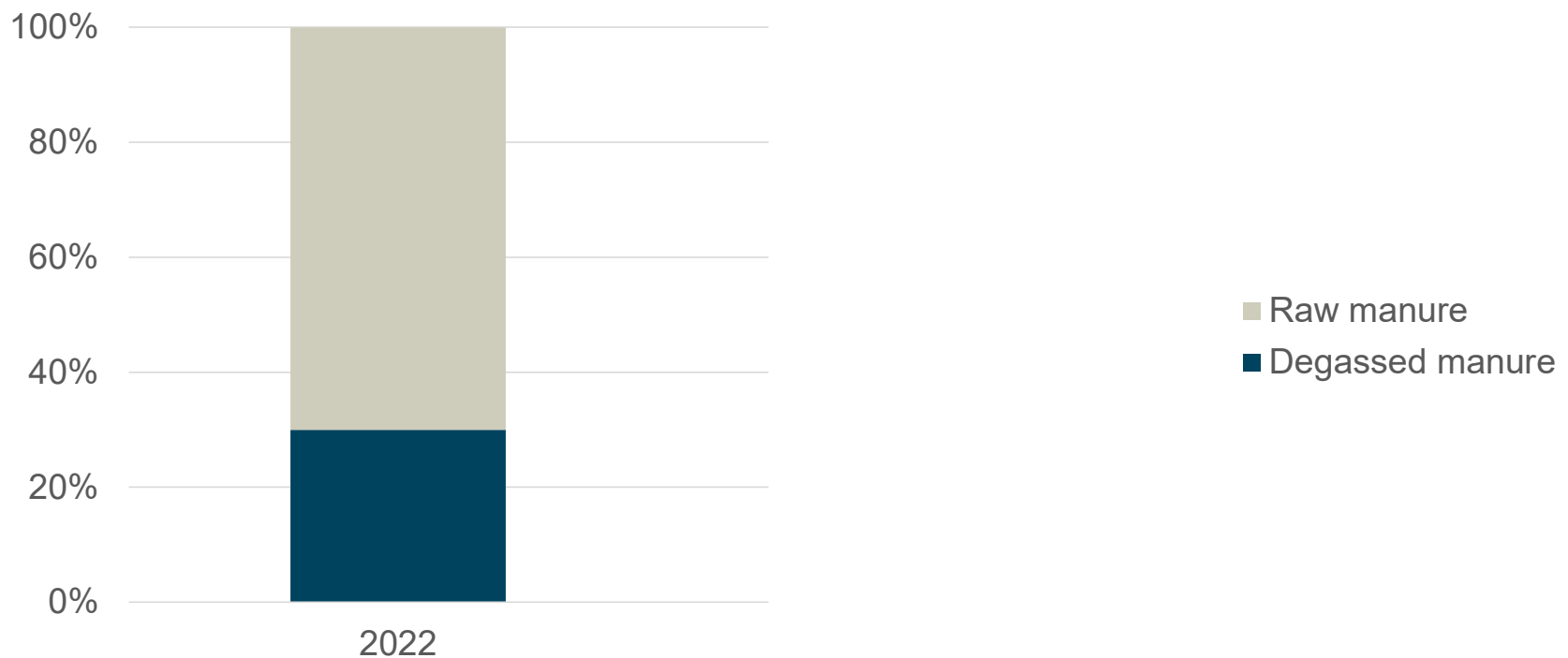
**SEGES
INNOVATION**

33 %

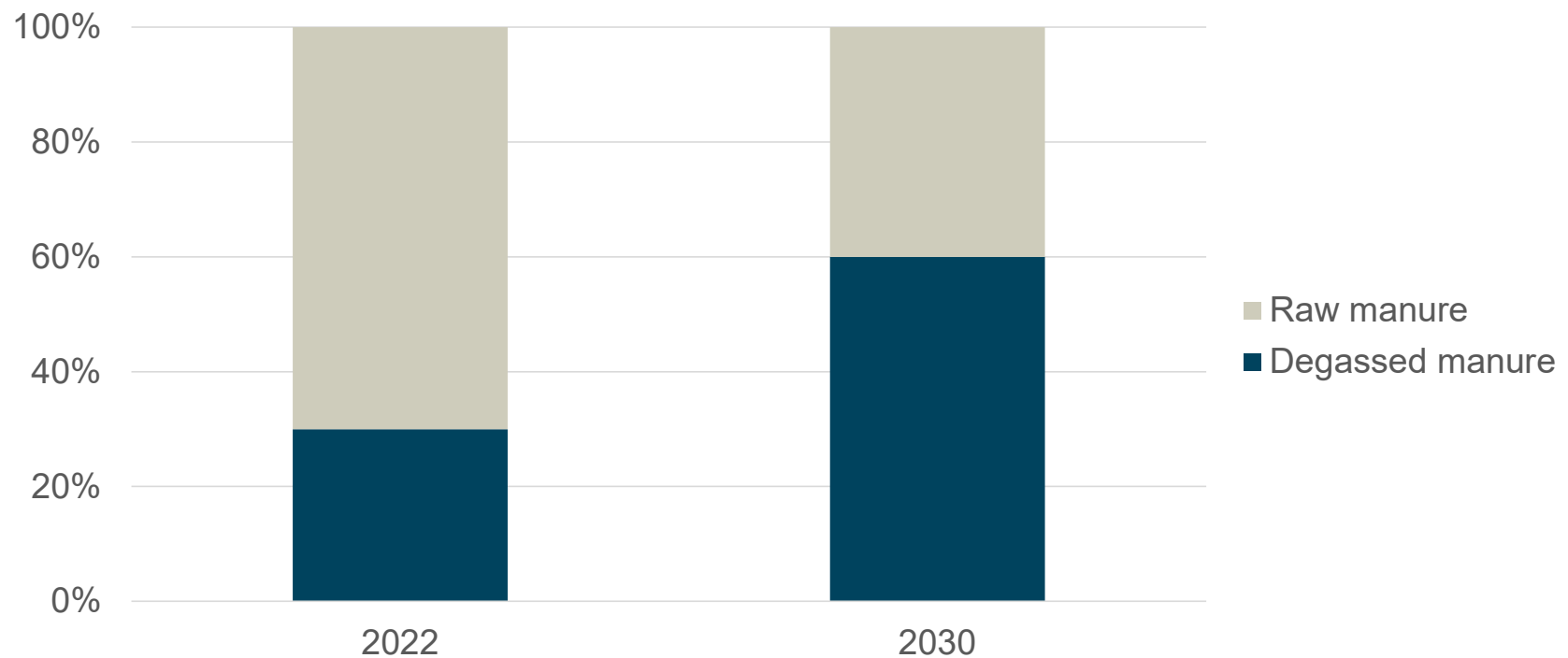
67 %



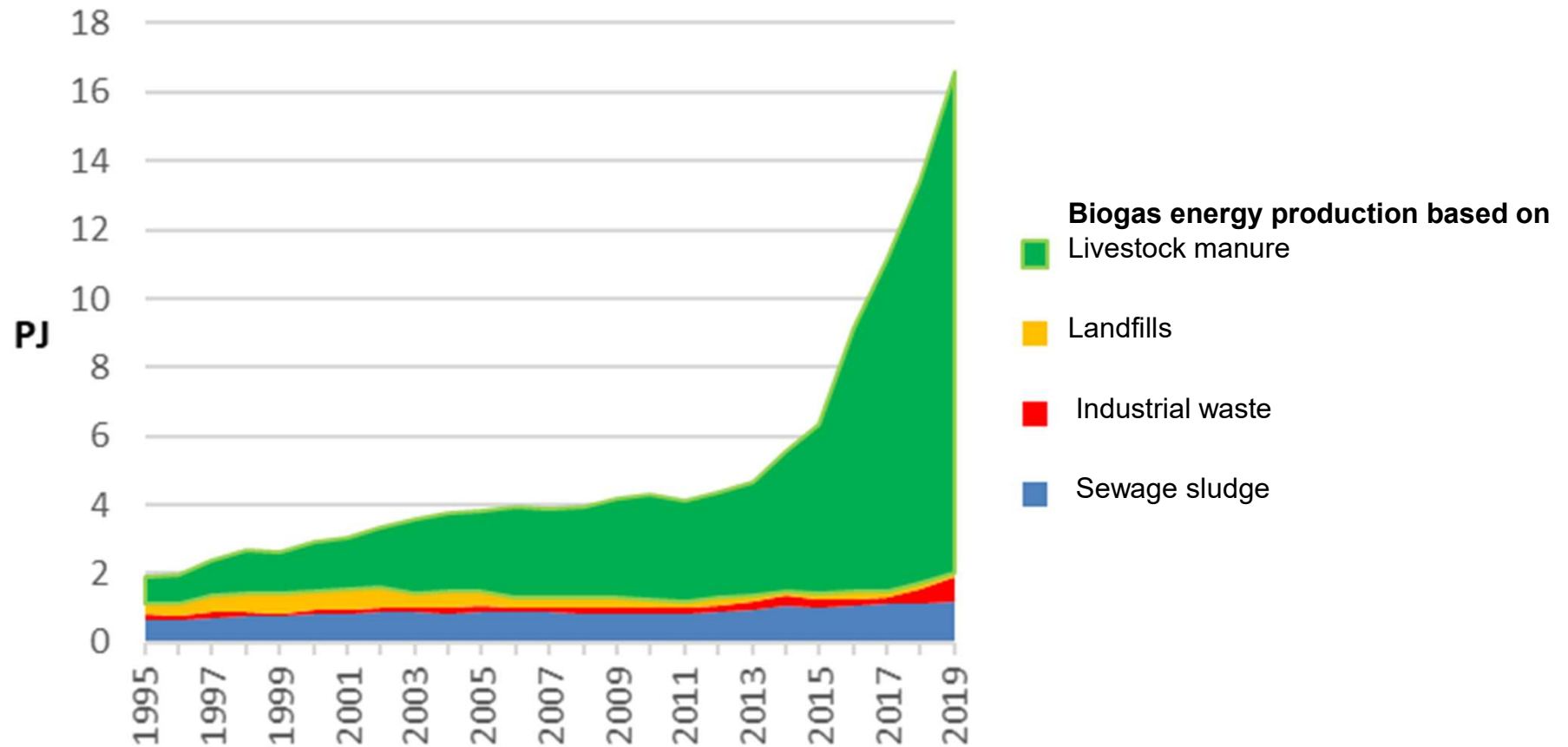
Approx 30% of Danish livestock manure is degassed today



And 60% is expected to be digested in 2030

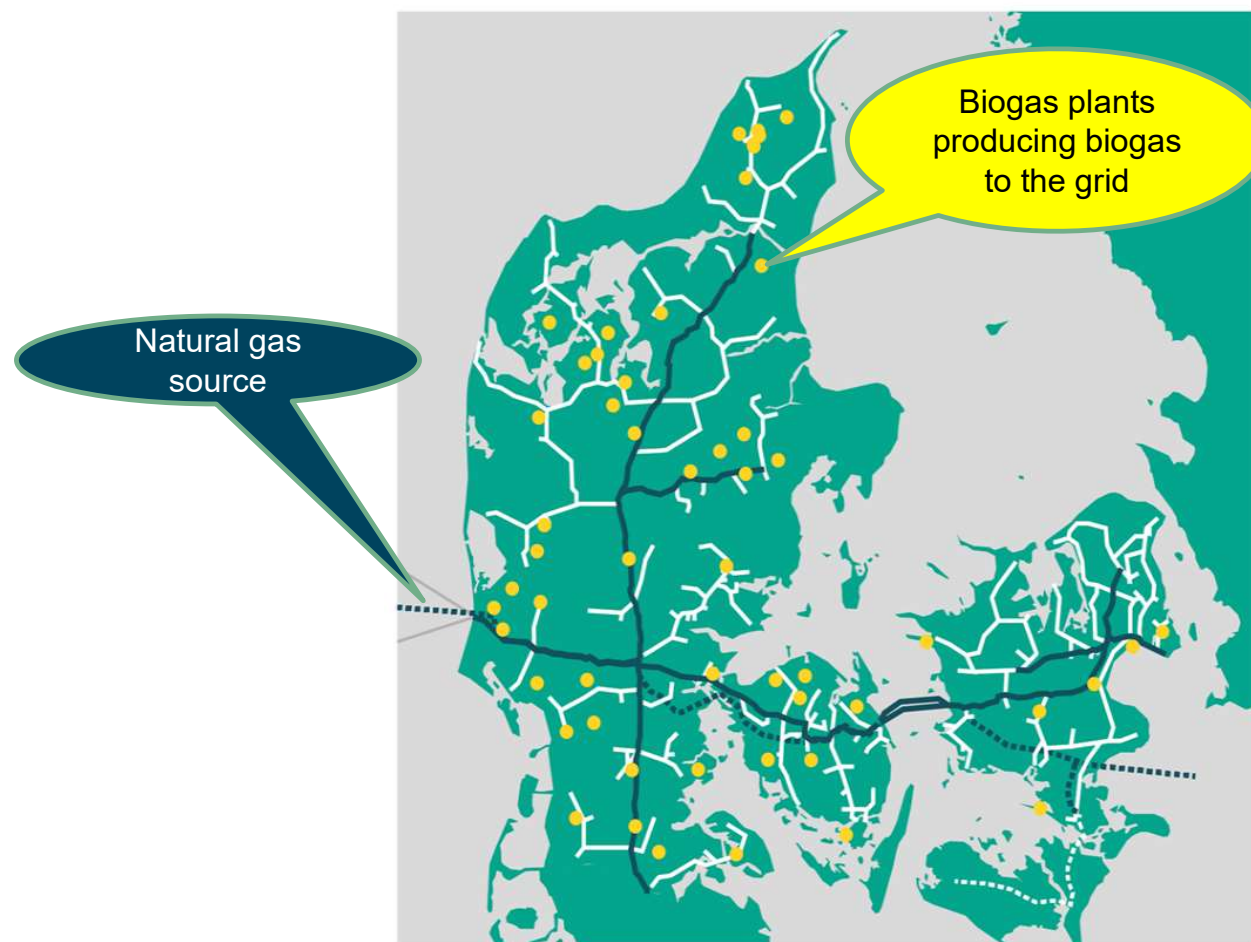


Biogas production, 1995 - 2019

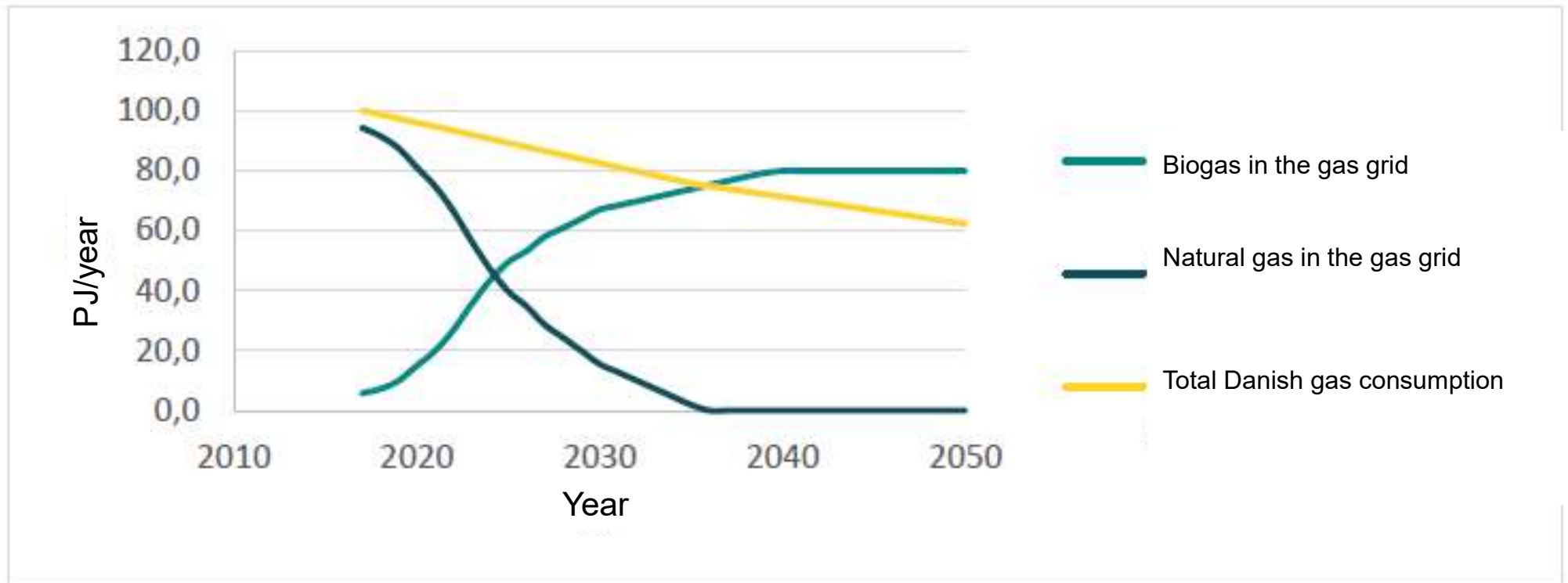


Source: Biogas Denmark

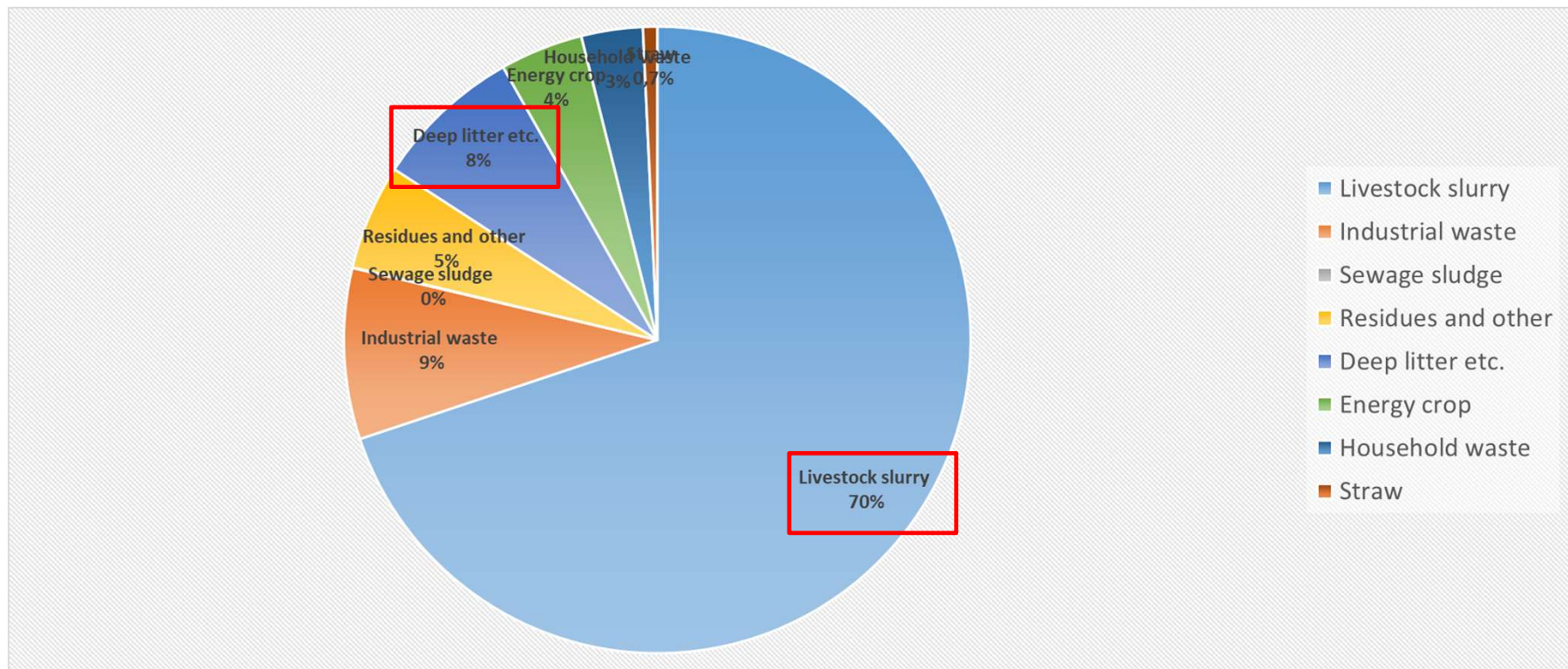
The Danish gas grid covers most of Denmark



Biogas is expected to cover the Danish gas consumption in 2035



Livestock manure makes up the majority of the biomasses used for biogas production



Source: The Danish Energy Agency 2019-2020

What is important for farmers who receive digestates from a biogas plant?

- Reduction of odour nuisances during land application
- Knowledge of the actual nutrient content
- Elimination of pathogens, weed seeds and parasites
- Reduction of climatic impact
- Possible higher fertilization value

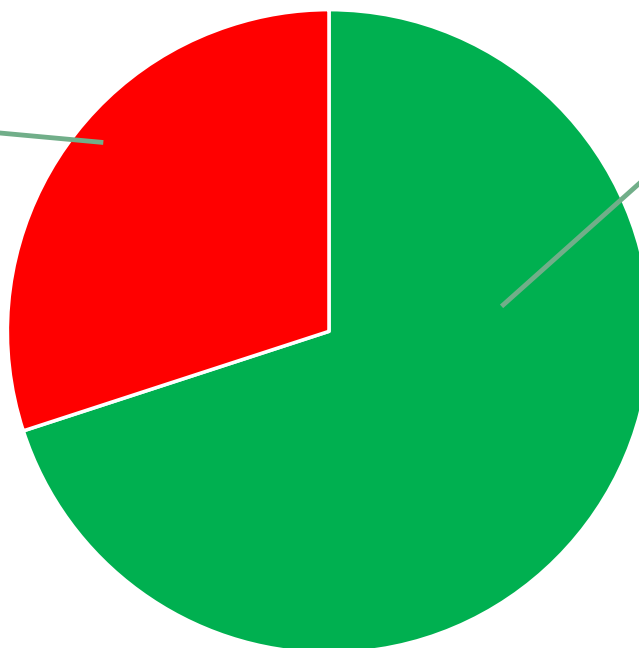
The higher the ratio of $\text{NH}_4^+\text{-N}$, the better

Organic N

- Has to be mineralized before it can be utilized by plants
- The nutrient effect is therefore often delayed relative to the demand of the crop
- Has a low fertilizer effect



Nitrogen content in digestates



$\text{NH}_4^+\text{-N}$

- Is readily plant available nitrogen
- Is taken up and utilized similar as N in mineral fertilizer
- Has a high fertilizer effect



Why is the biogas treatment important for the fertilizer value of slurry?



Cattle slurry



- NH4-N - good nitrogen
- Organic N - not so good nitrogen

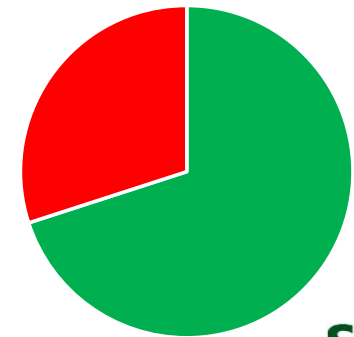


Anarobic digestion of livestock slurry

- Reduces the DM content
- Increases slurry pH
- Increases the ratio of $\text{NH}_4\text{-N}$



Digested cattle slurry



- NH4-N - good nitrogen
- Organic N - not so good nitrogen

SEGES
INNOVATION

The type of organic waste products influences the composition of the digested slurry, and therefore its fertilization value.



Cattle slurry



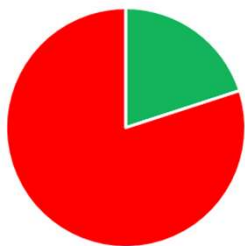
Other biomasses



Digested slurry



Deep litter



■ NH4-N ■ Organic N

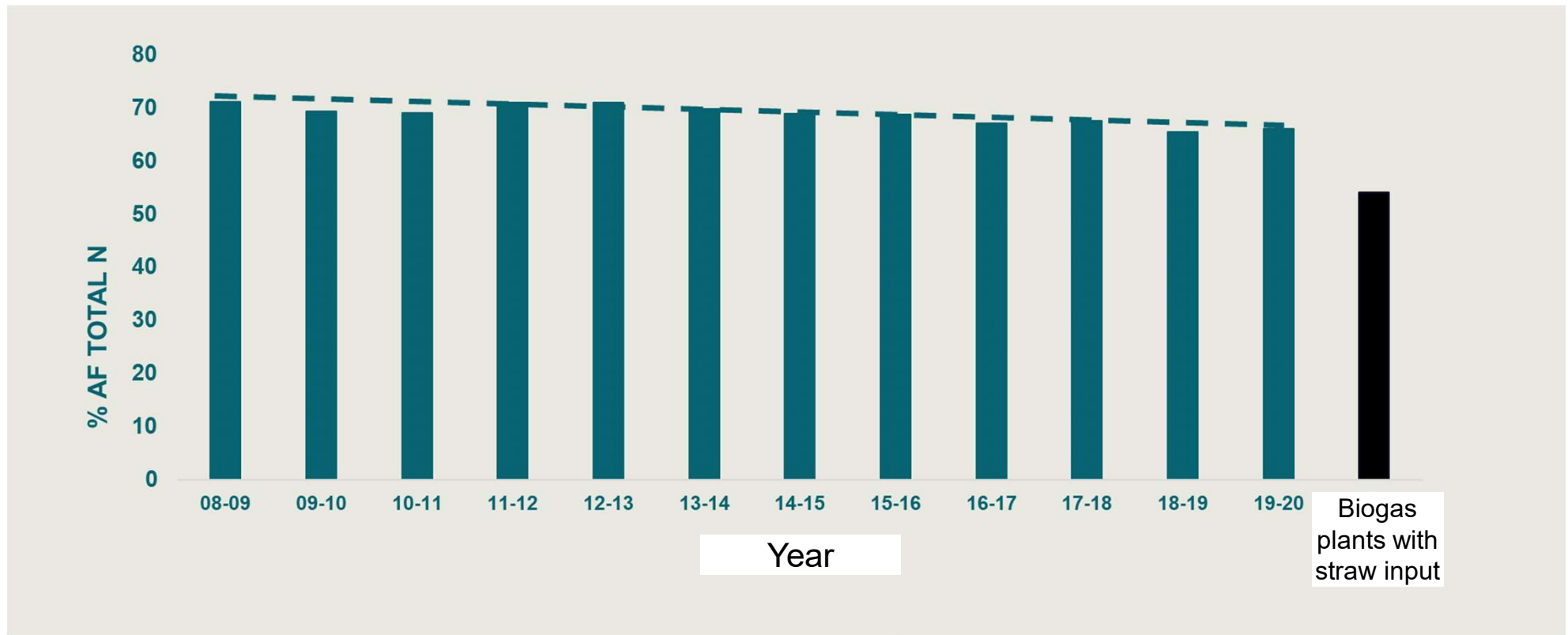
Types of organic residues/“wastes”

- **Industrial**, wastes/by-product/commodities from agriculture, feed industry and households/waste-treatment/cities
- **Agricultural** residues/waste products from plant production (Have in general a high dry matter content, low degradability and a relative low nutrient content)
 - Straw
 - Deep litter
 - Crop residues
 - Corn/grass silage
 - Catch crops, etc.

Effects of inputs of agricultural waste products (in general)

- Increases the dry matter content of the digested slurry
- Decreases the ratio of $\text{NH}_4\text{-N}$

Higher input of biomasses of low "nutrient value" has decreased the $\text{NH}_4\text{-N}$ content of Danish biogas slurry



And how do we best handle the digestates?

Storage facilities must be covered to reduce loss of nitrogen by ammonia emission

- Either by cover of the storage facility

Or by covering the slurry surface

Either formed naturally by the digestates

Or by addition of straw or other floating materials



Foto: Torkild Birkmose, SEGES



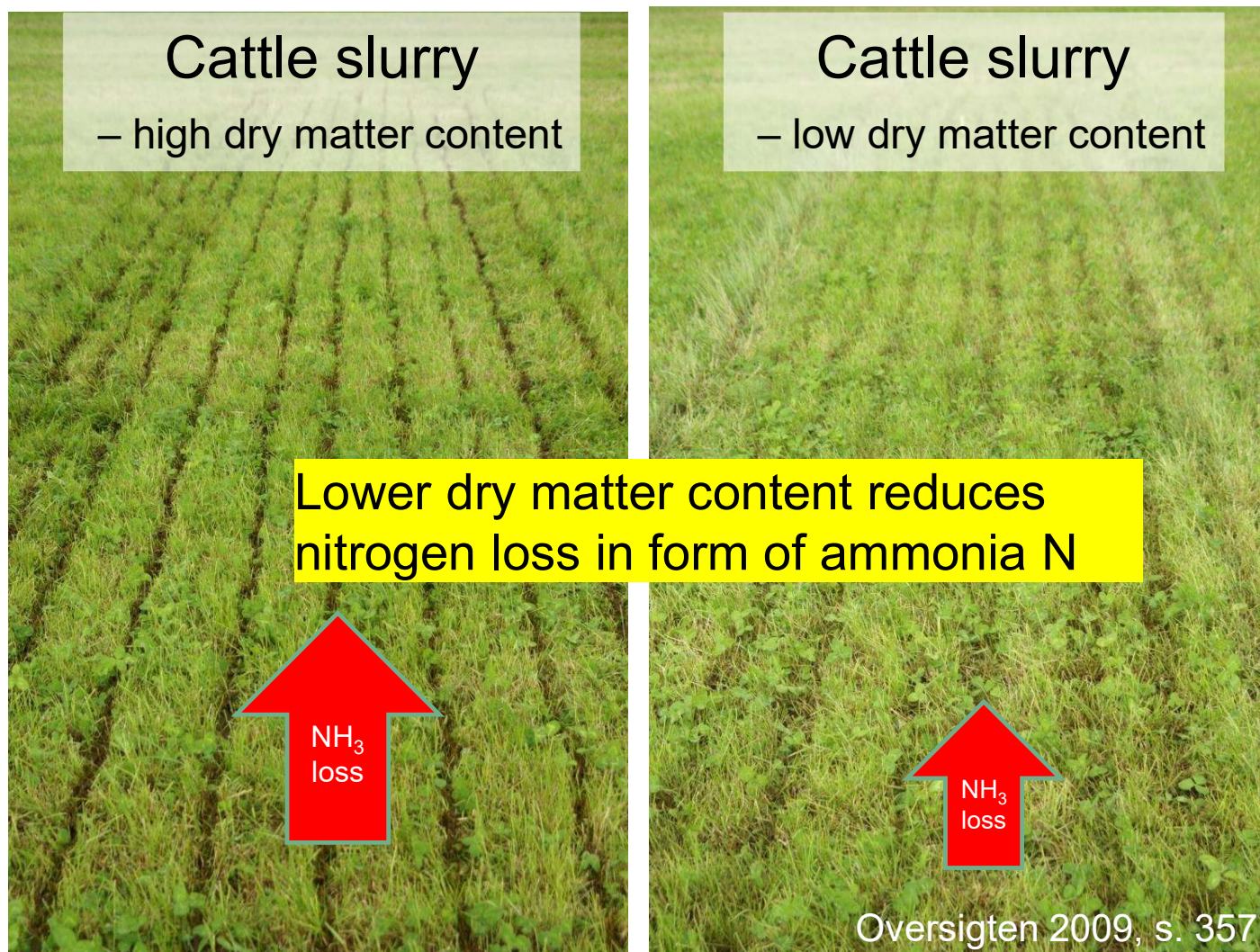
Natural crust, digestate store

Foto: Kristian Furdal, SEGES

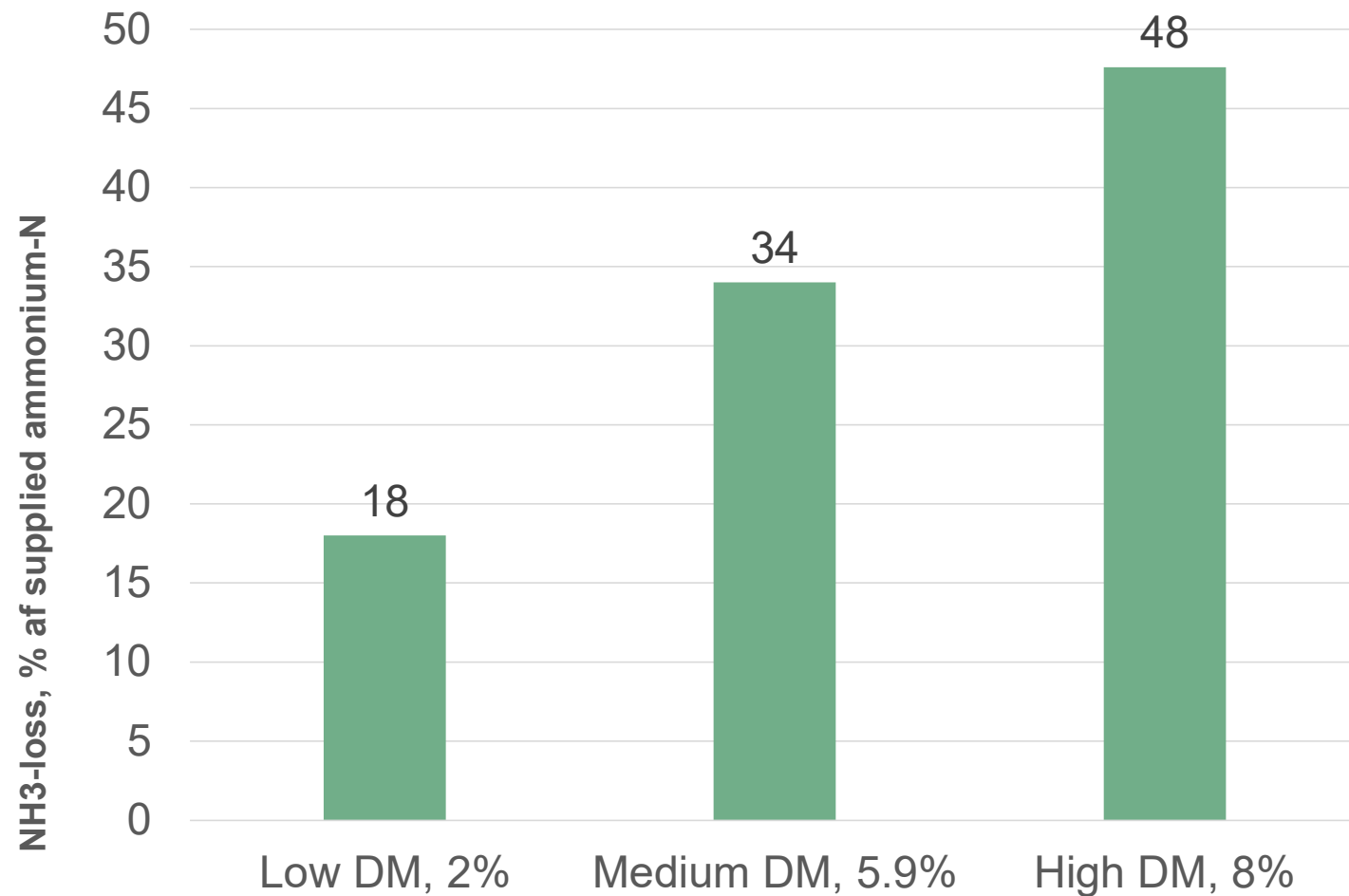


Straw cover, digestate store

The lower the dry matter content, the better



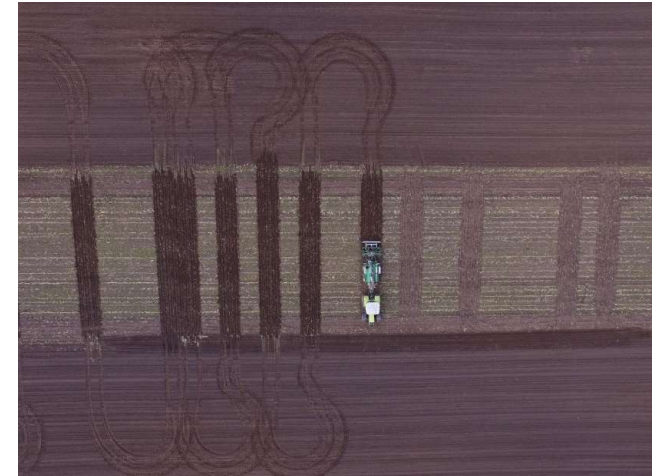
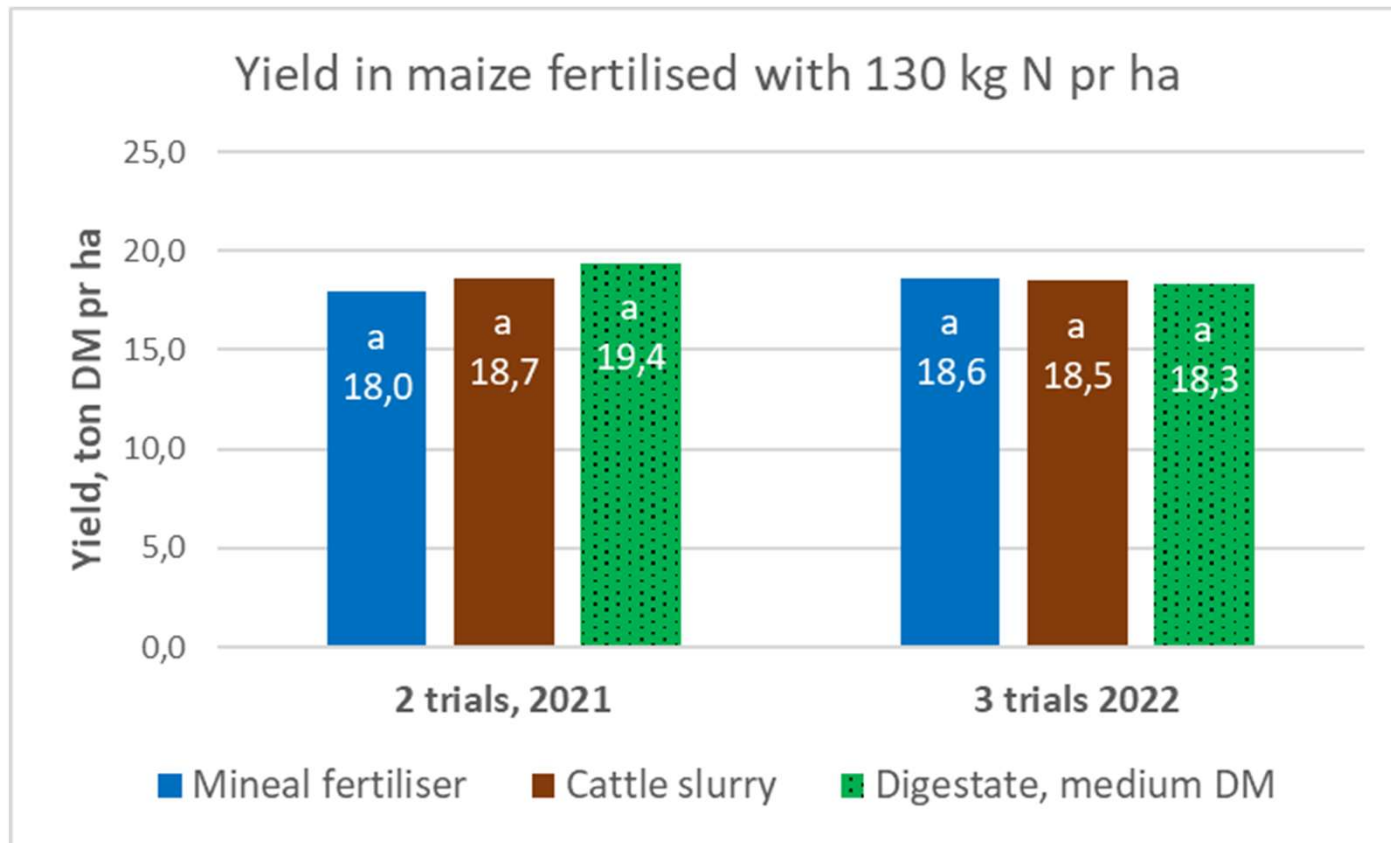
Loss of N by ammonia emission from digestates trialing hose applied to winter wheat



The risk of ammonia loss can be reduced by the choice of land application technology

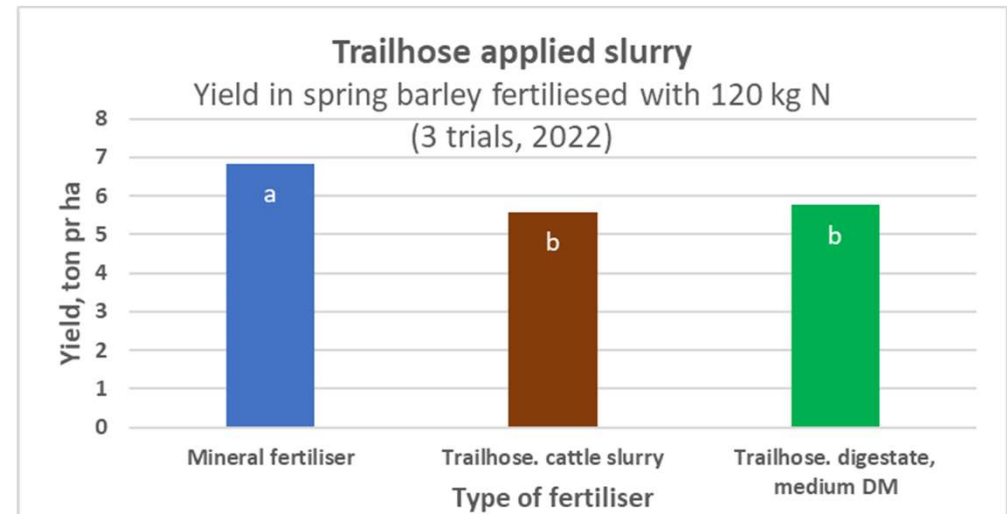
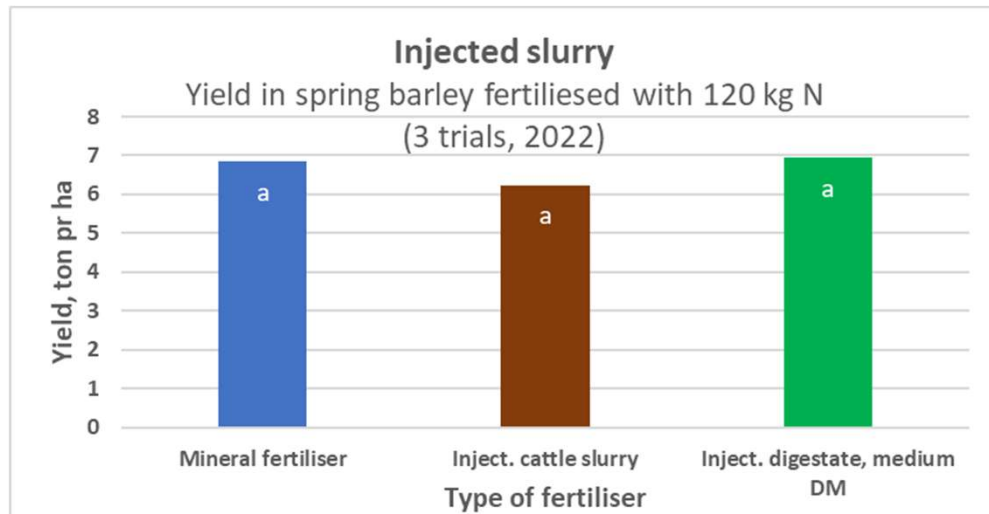


Soil injected digestates have the same fertilisation effect as mineral fertiliser and cattle slurry in maize



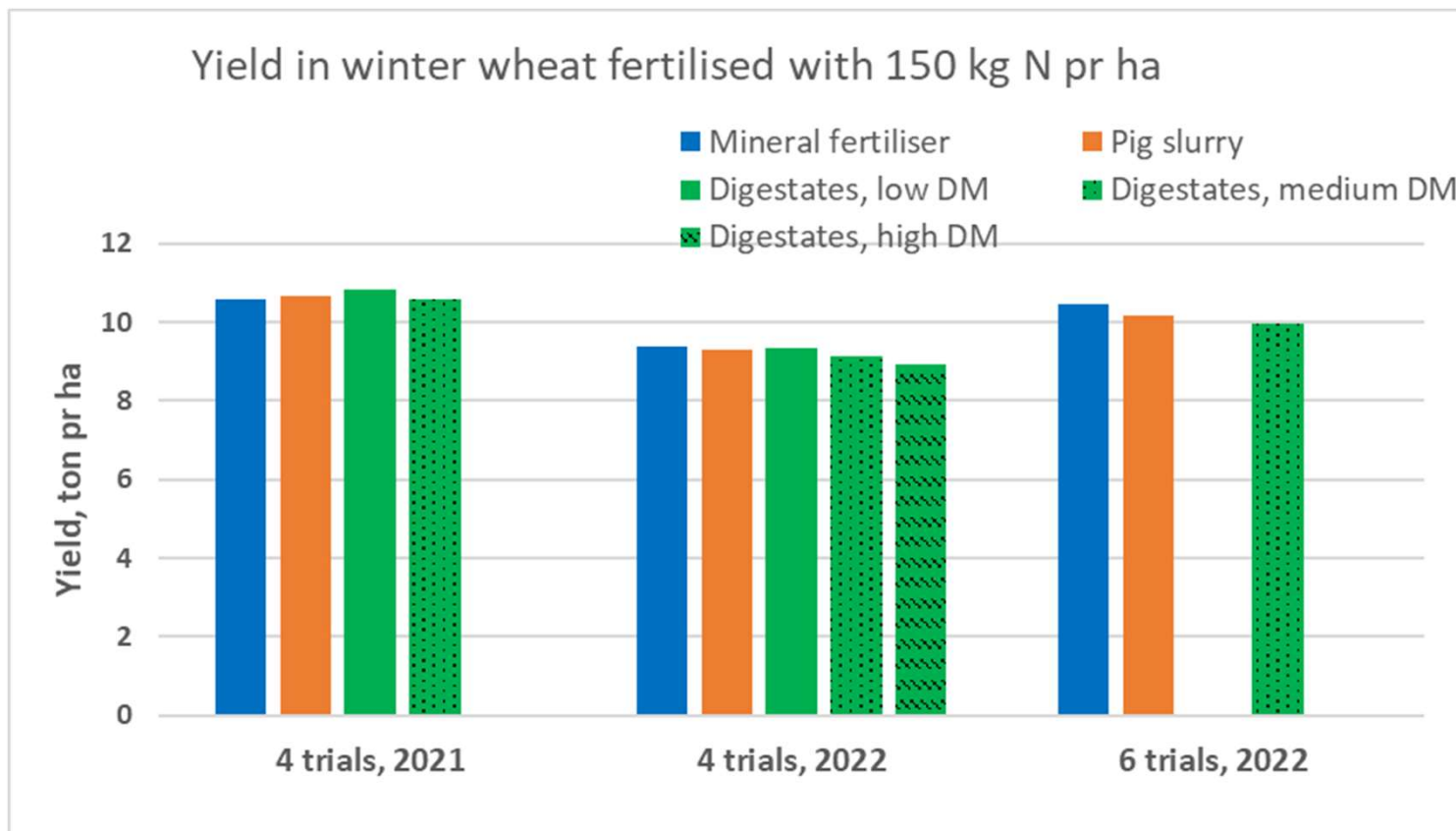
INNOVATION

The nutrient effect of digestates is depending on application time and application technology in spring seed



The nutrient effect of digestates is similar to mineral fertiliser and pig slurry in winter seed

- However, the nutrient effect is depening on the the dry matter content of the digestate – and thereby by the use of dry matter rich biomasses like straw and deep litter at the biogas plant

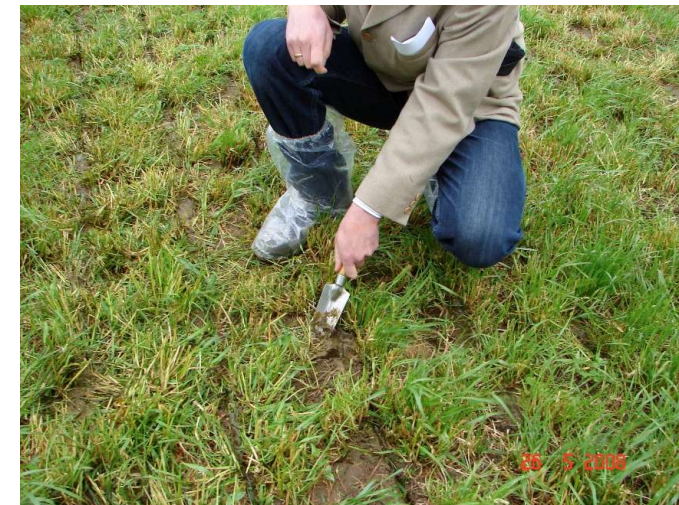
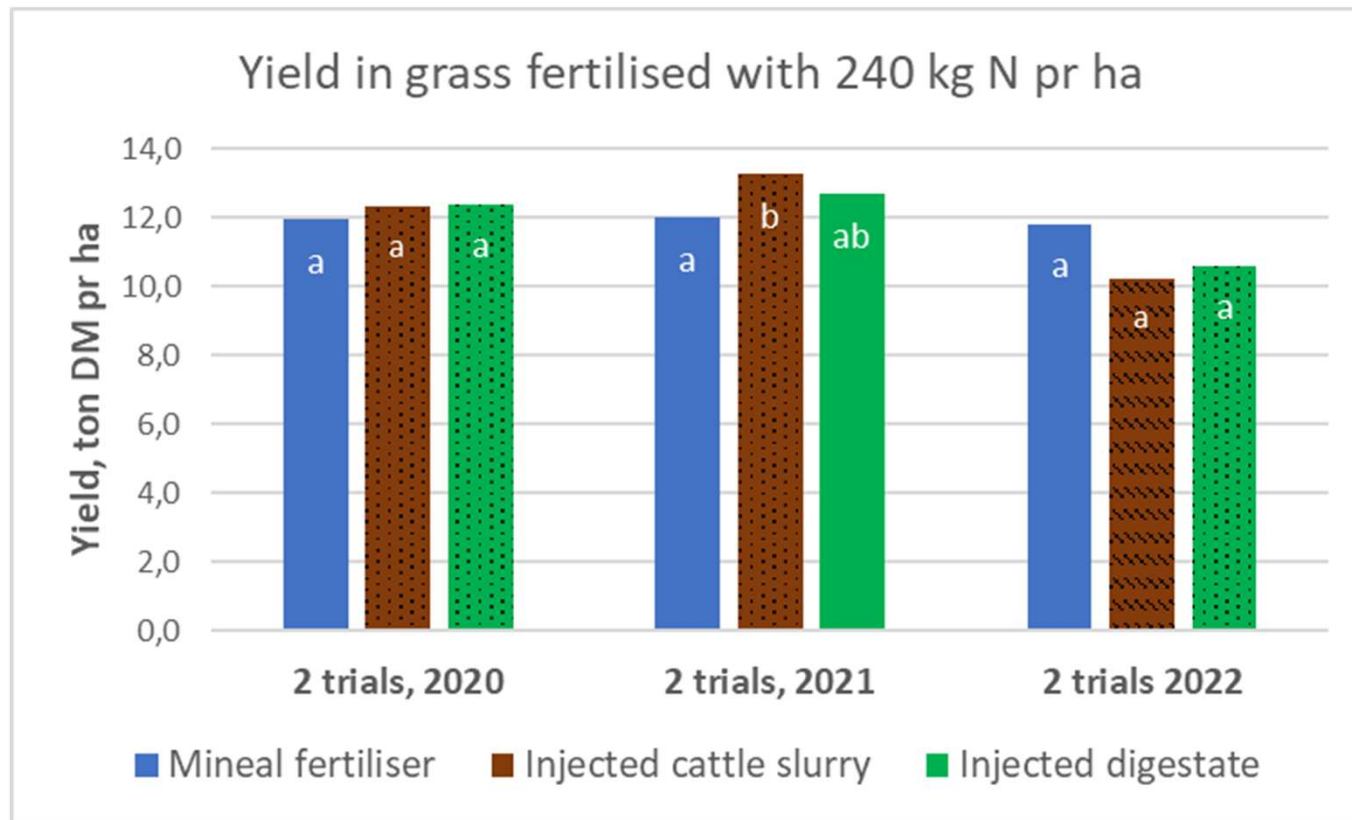


The higher dry matter content of the digestates, the higher loss of nitrogen by ammonia emission from surface applied slurry



The nutrient effect of digestates is similar to mineral fertiliser and cattle slurry in grass. Given that the slurry is injected.

- However, also in grass the nutrient effect is depending on the dry matter content



Take home messages

- Biogas treatment improves the nutrient value of organic biomasses
- The nutrient value of digestates is in general similar to the nutrient value of mineral fertilisers.
 - However, the nutrient value of digestates is depending on the types of biomasses used at the biogas plants.
 - The higher use of biomasses with low content of plant available nitrogen ($\text{NH}_4\text{-N}$) and high dry matter content, the lower nutrient value of the digestate
- The best nutrient value is achieved when the ammonia loss is reduced by use of ammonia abatement technologies – both during storage and land application
 - Use of abatement technologies is in particular requested for application of dry matter rich digestates.

Thank you for your attention!



Foto: Torkild Birkmose, SEGES