

# Nutrient value of digestates

**Martin N Hansen**

Senior Consultant. Ph.d.

Plant & Environments, SEGES Innovation

Promilleafgiftsfonden for landbrug



How can South Africa increase the use of digestate as a safe and affordable fertiliser? 08-11-2023 Webinar.

**SEGES**  
INNOVATION

# Short about SEGES Innovation

**We connect science to practical farming**



**SEGES**  
INNOVATION



We make knowledge from universities, the industry, from abroad, and from our own studies available for farmers and their consultants



## Short about SEGES Innovation

- Knowledge center for agricultural production
- We are about 500 employees
- We cover all aspects of agricultural production
  - Health & animal welfare
  - Management and economy
  - Digitalization
  - Climate & sustainability
  - **Crops & environment**





The Danish biogas industry has become a very important producer of energy – **and fertilizer**



## Biogas have several important effects!

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

**...all effects are very important agricultural, political, and social agendas!**





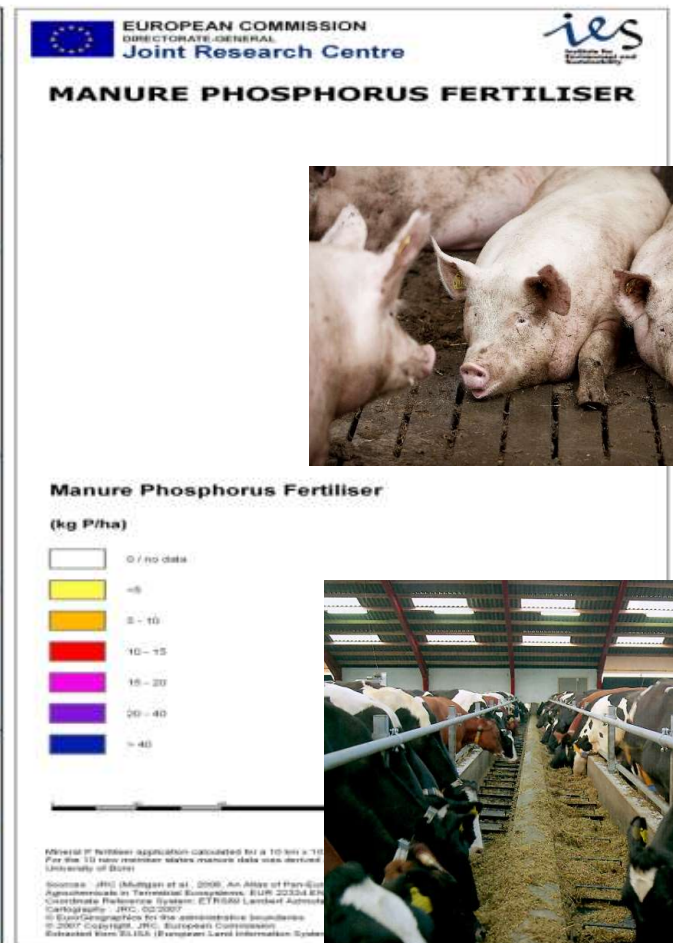
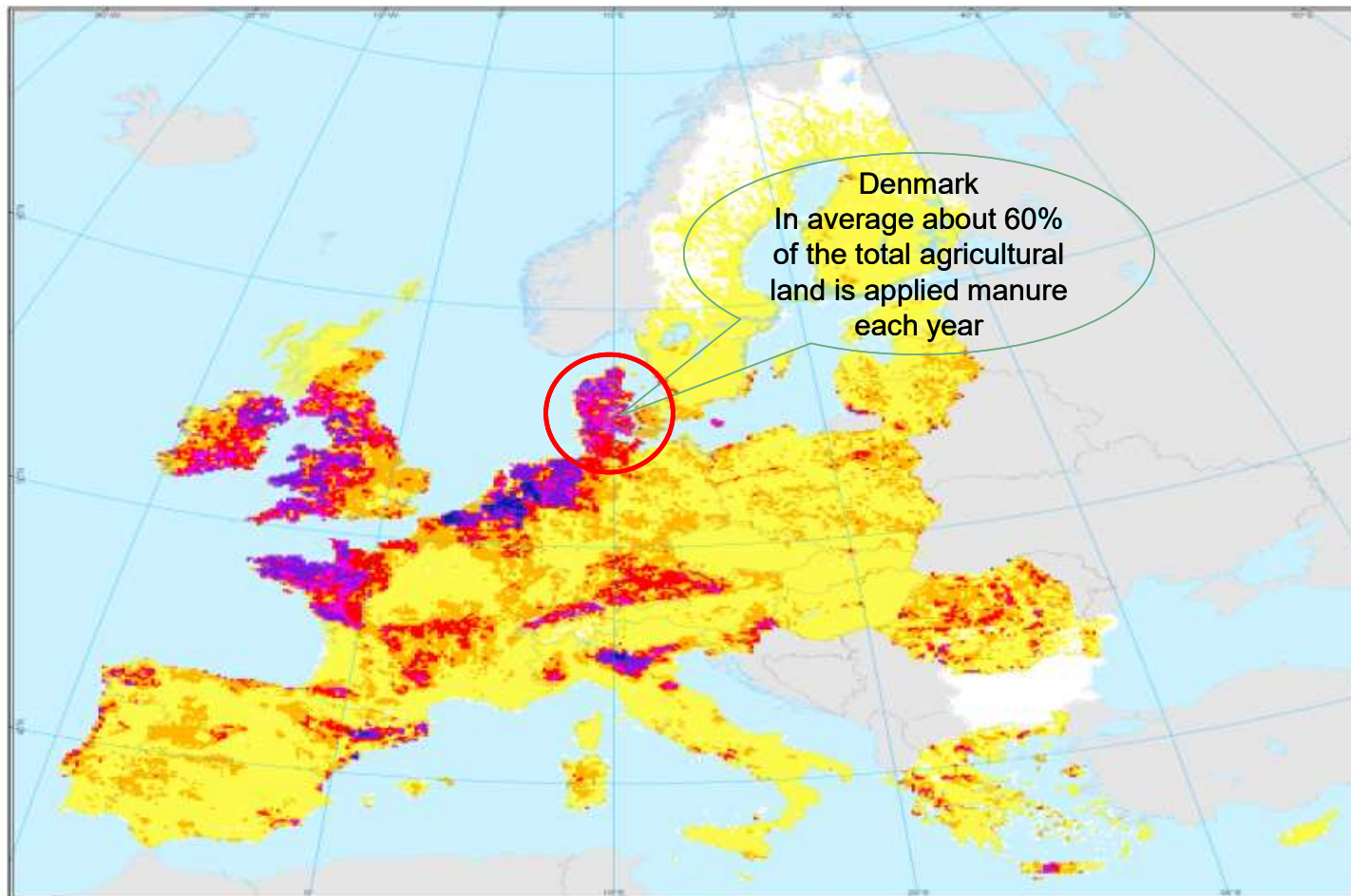
## Biogas have several important effects!

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

**...all effects are very important agricultural, political and social agendas!**



# Denmark has a very high manure production, and livestock manure is the most important fertilizer we have



**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



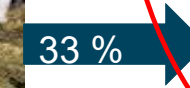
**Biogas  
production**



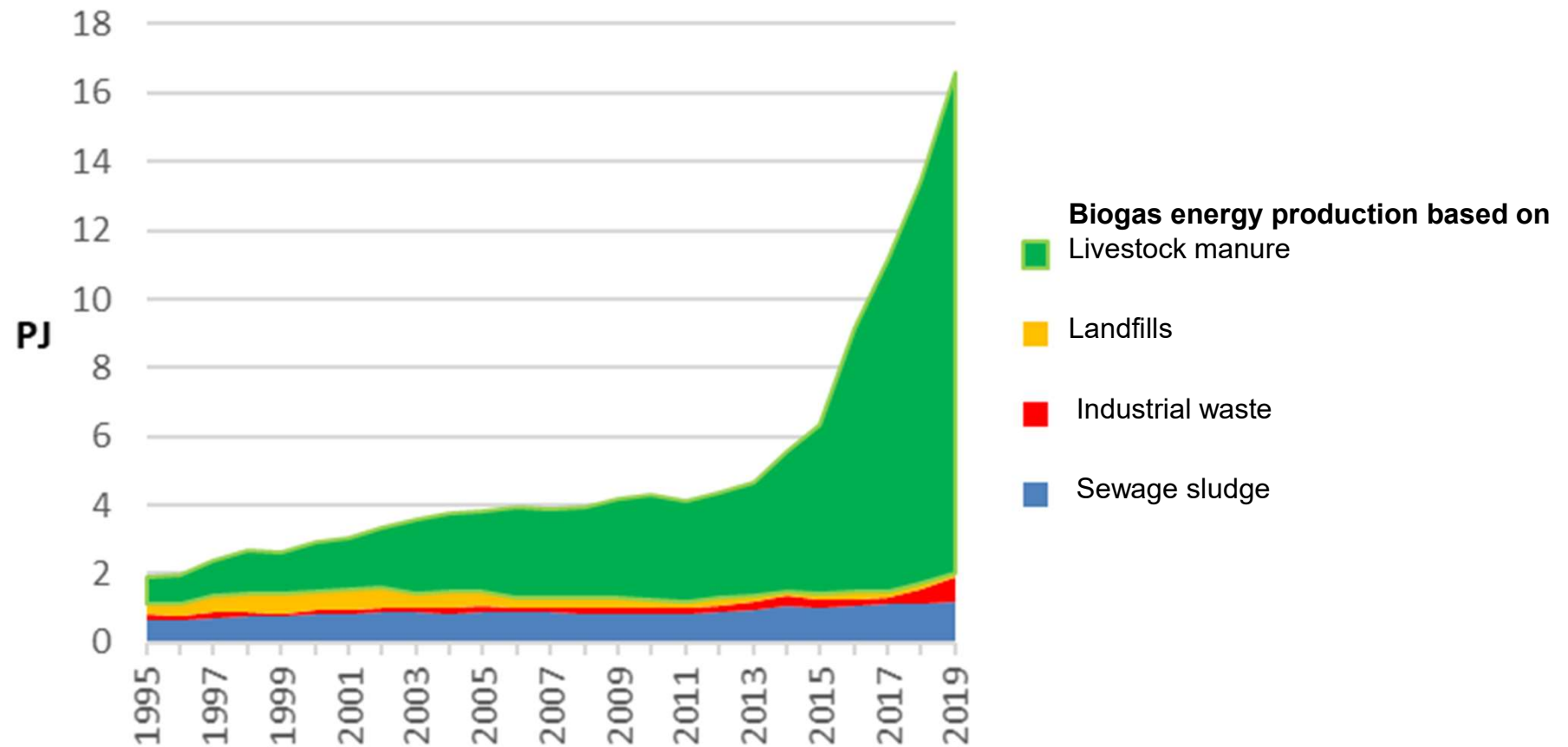
**SEGES  
INNOVATION**

33 %

67 %



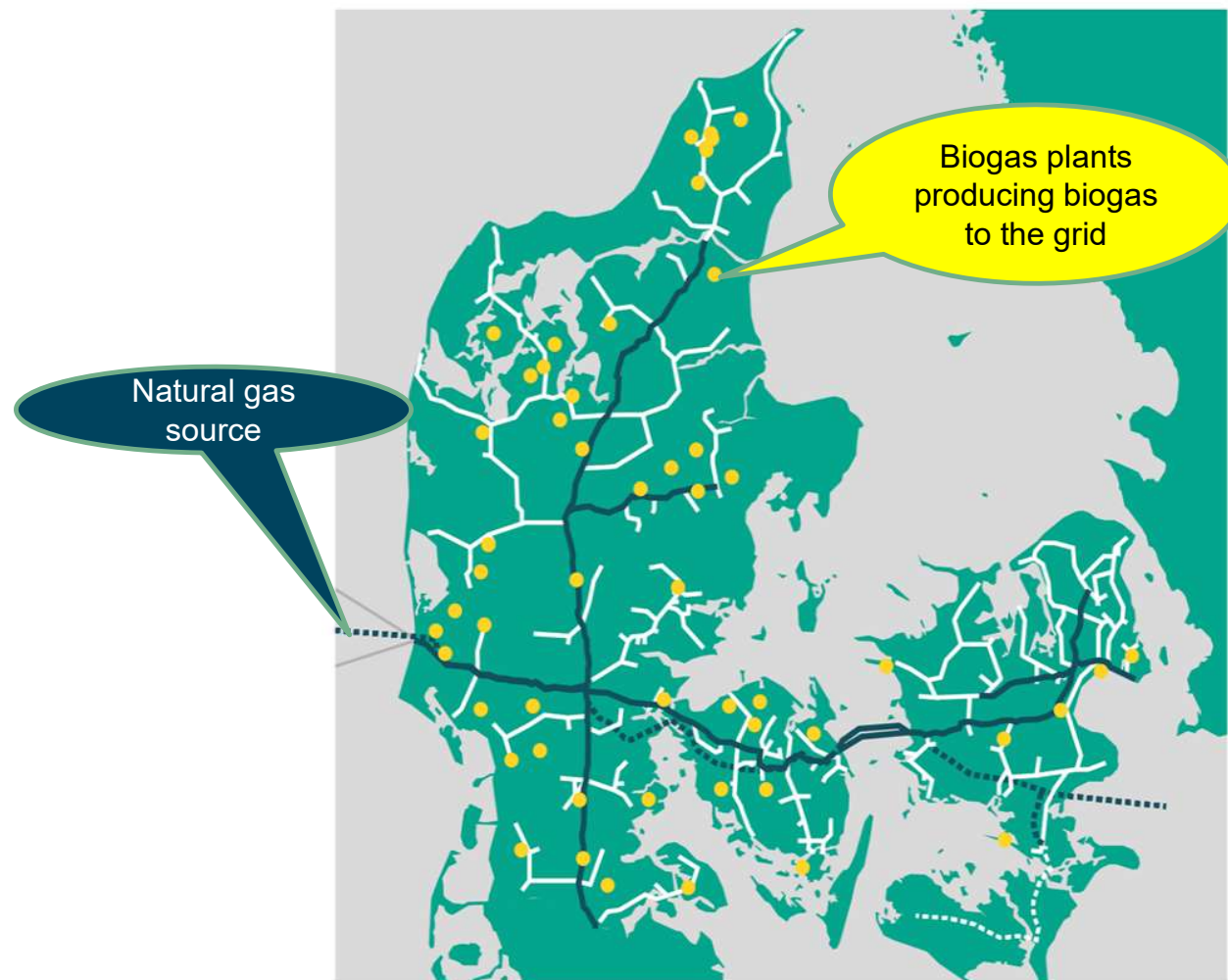
## Biogas production, 1995 - 2019



Source: Biogas Denmark

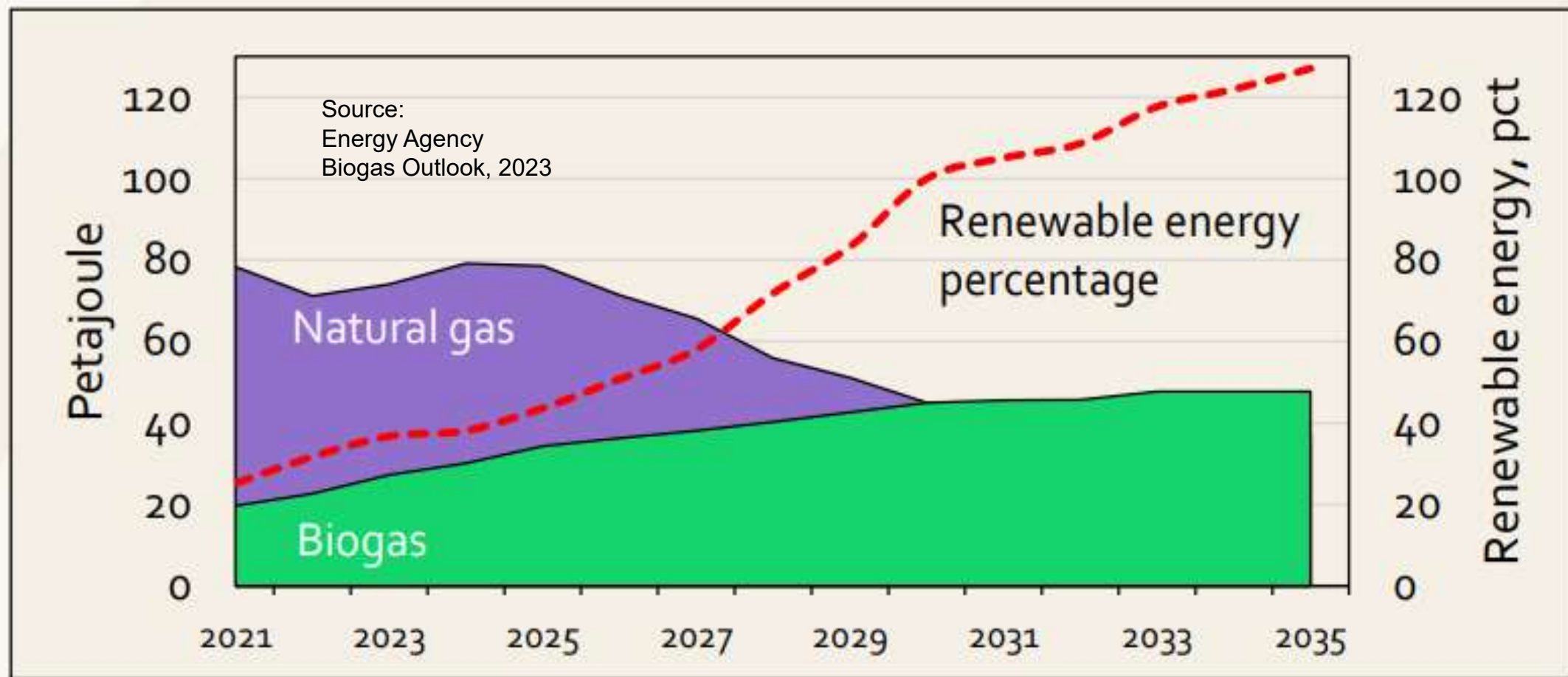


## The Danish gas grid covers most of Denmark



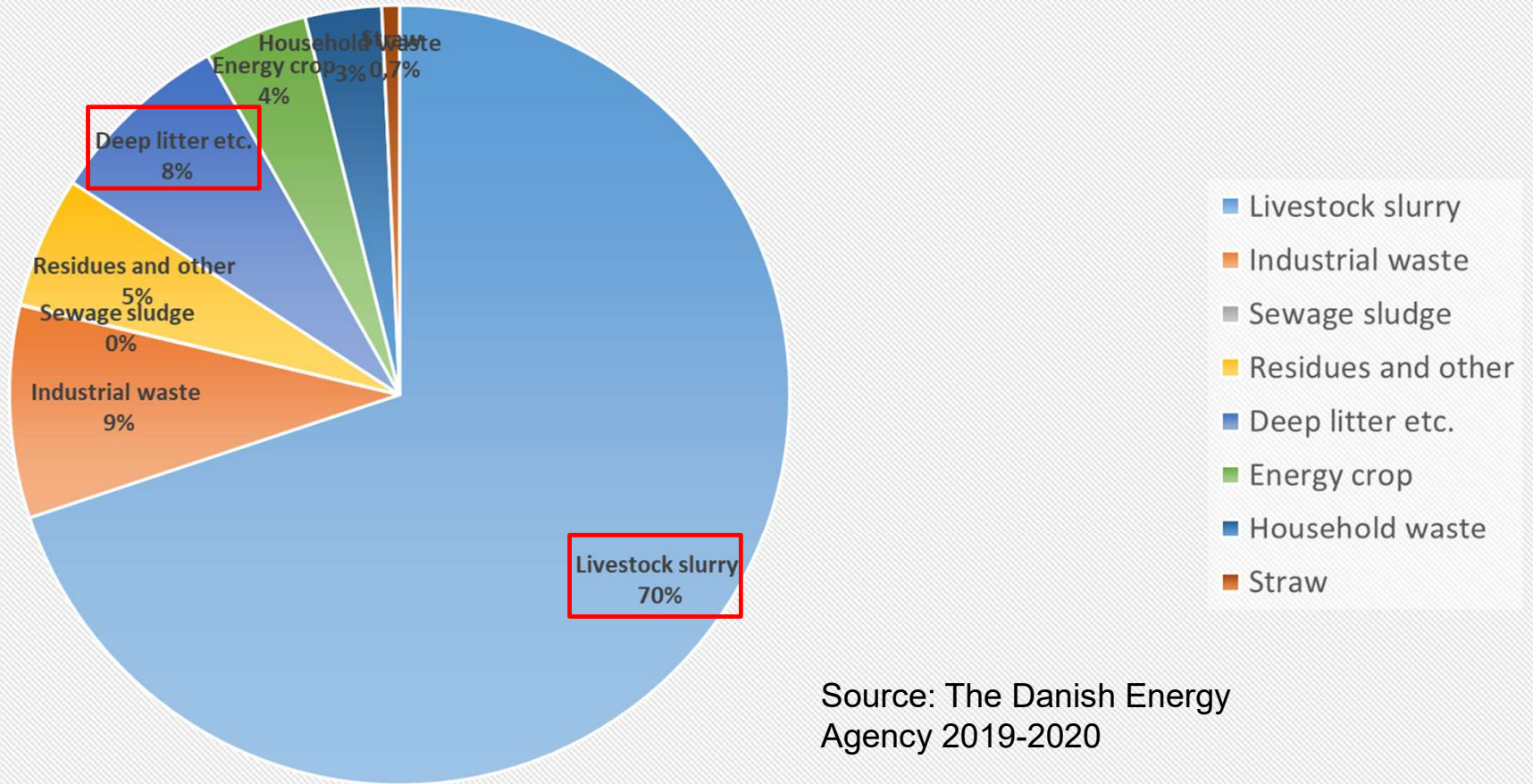
## Biogas is expected to cover the Danish gas consumption in 2030

Future gas consumption and biogas supply in grid - Energy Agency Scenario





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



## 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



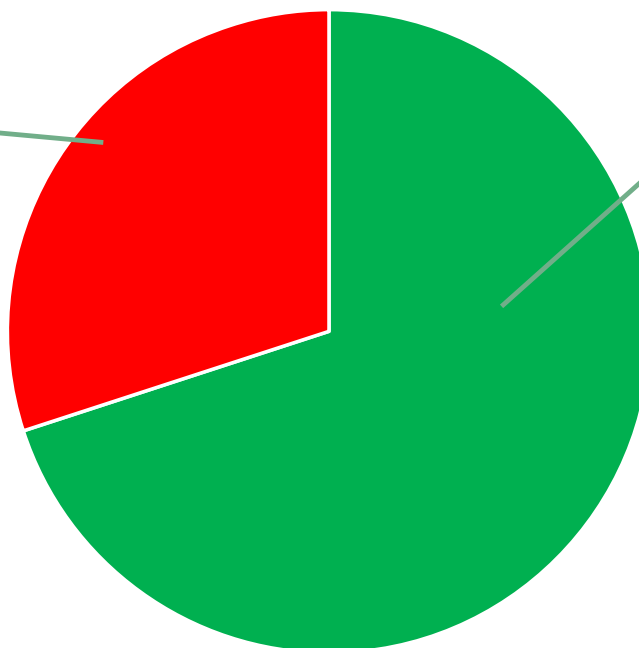
## The higher the ratio of $\text{NH}_4^+\text{-N}$ , the better

### 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

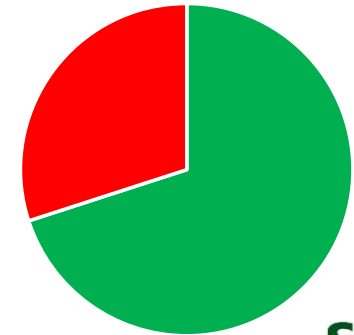


## Anarobic digestion of livestock slurry

- 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



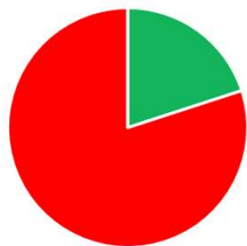
Other biomasses



Digested slurry



Deep litter



■ NH4-N ■ Organic N

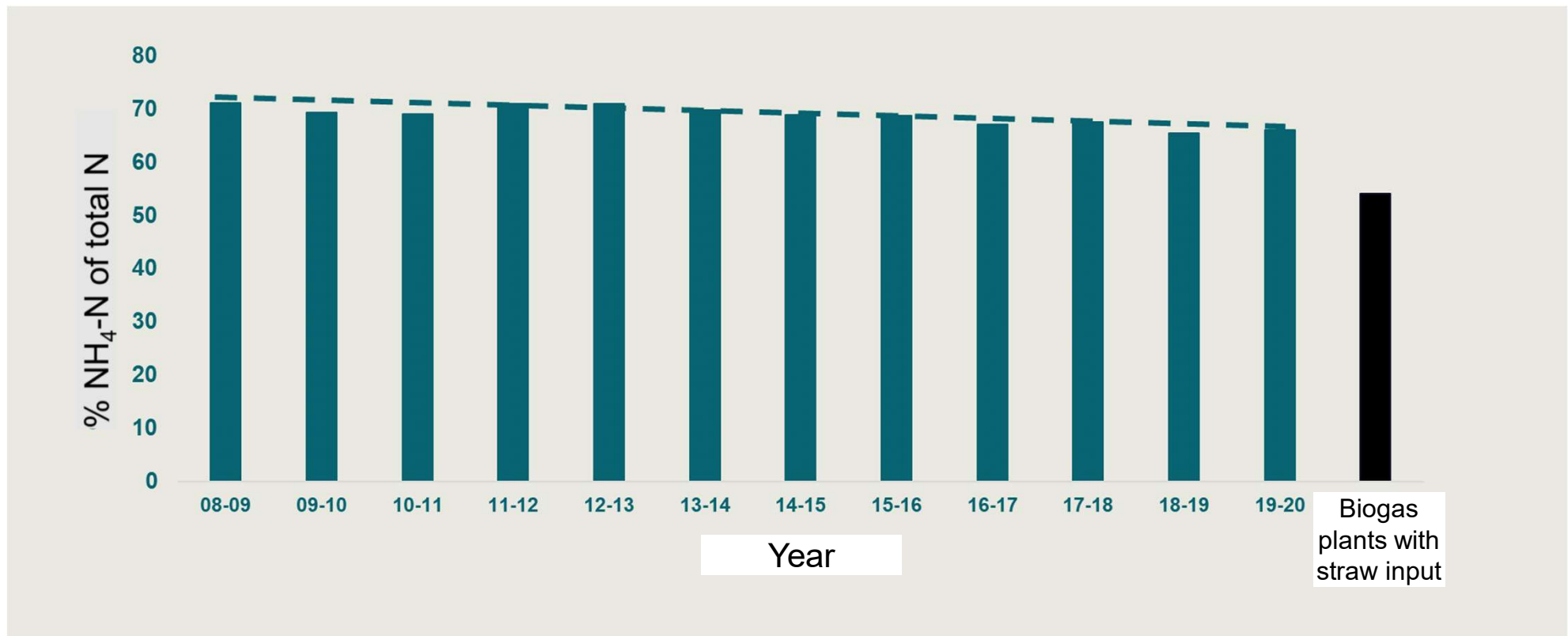
## Types of organic residues/“wastes”

- **Industrial:** Wastes/by-product/commodities from slaughter, fish, feed industry and households/waste-treatment/cities
- **Agricultural:** Residues/waste products from livestock and 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 digestate



# And how do we best handle the digestate?

## 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 by a natural crust

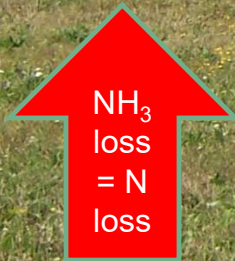
Or by addition of straw, or other floating materials



N loss without cover: 21% of total N content  
N loss with covering of slurry surface: 4% of total N  
N loss with cover of the storage facility: 2% of total N

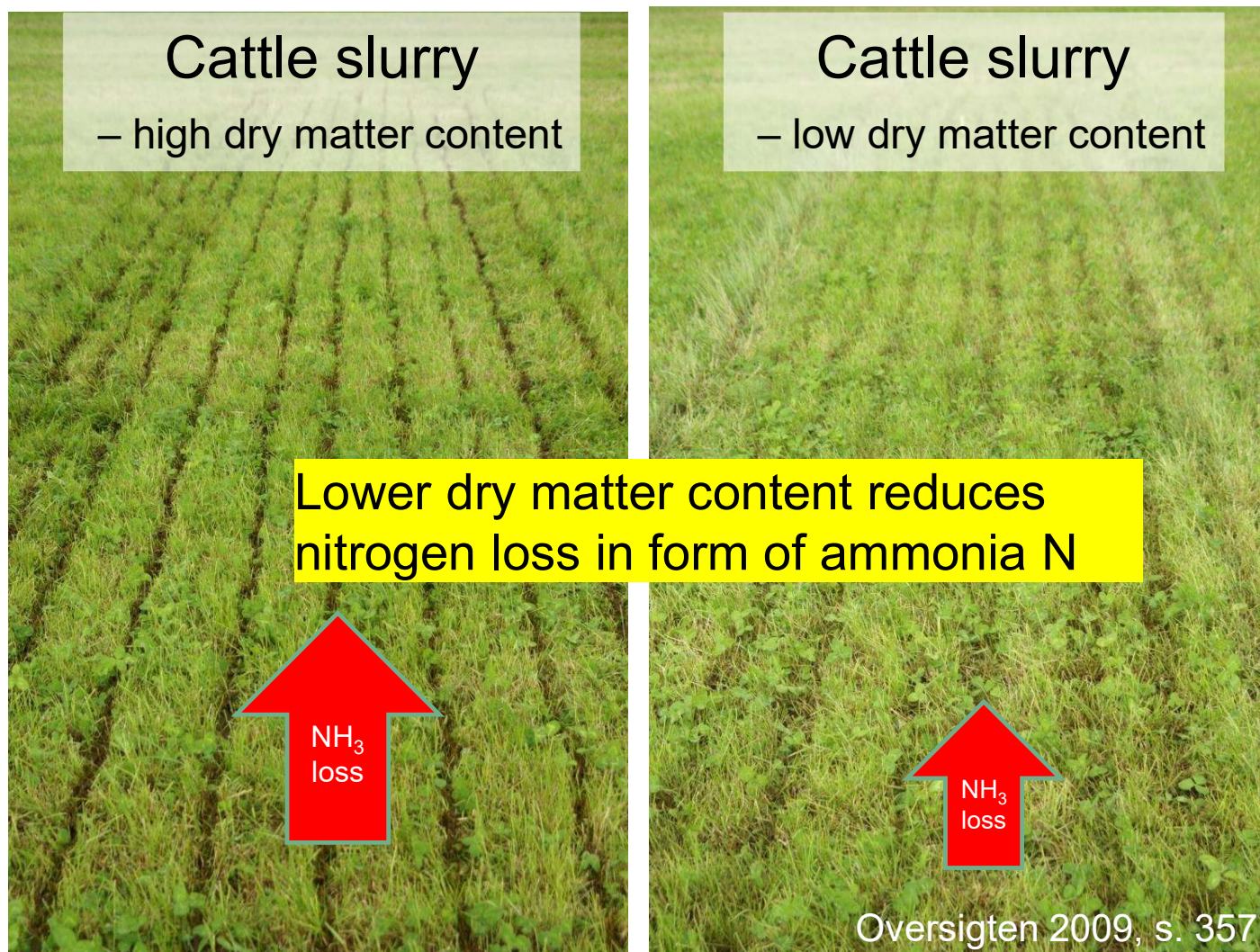


Be also aware of nitrogen loss following land application



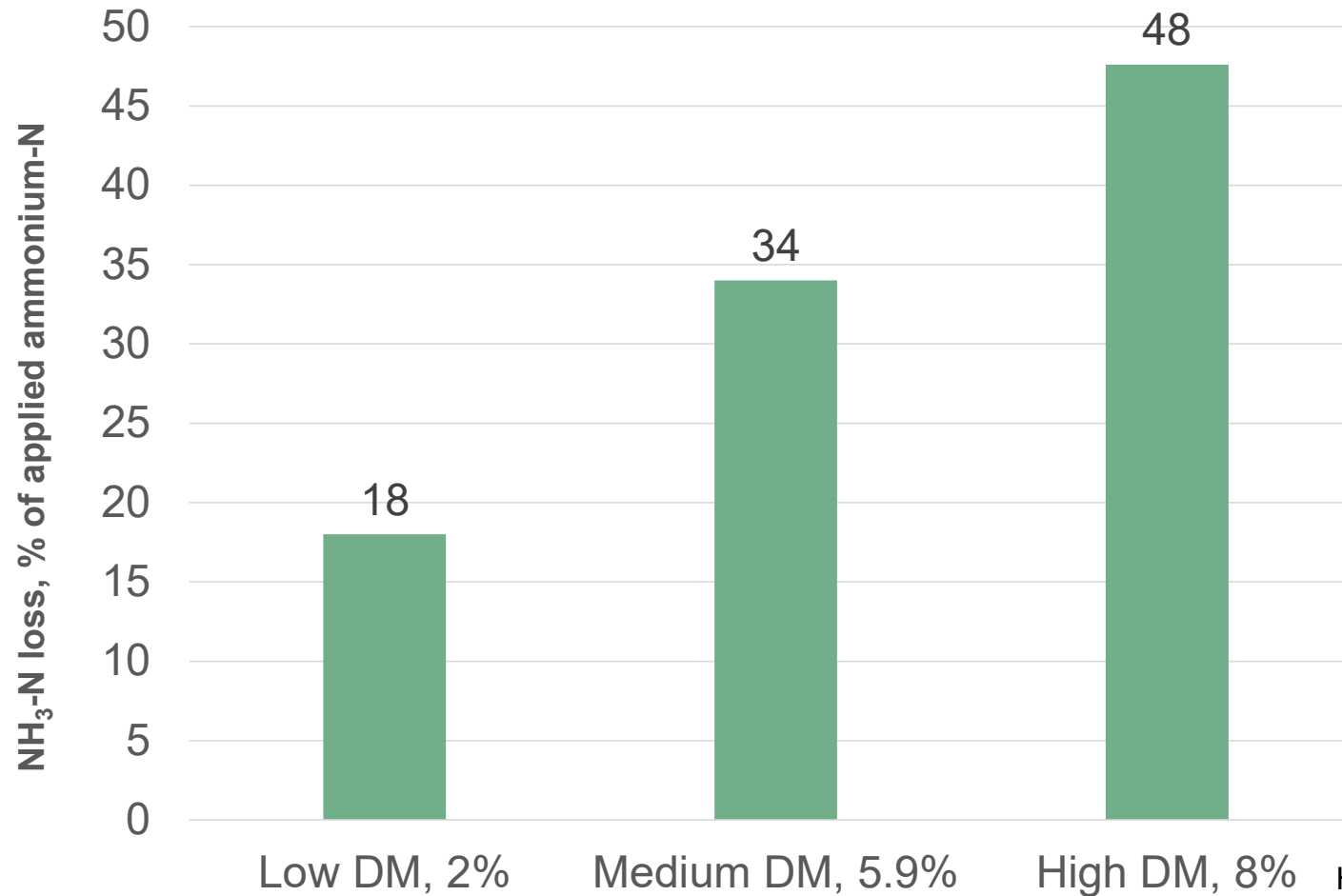


## The lower the dry matter content, the better



## Loss of N by ammonia emission from digestates

Applied by trailing hoses to winter wheat



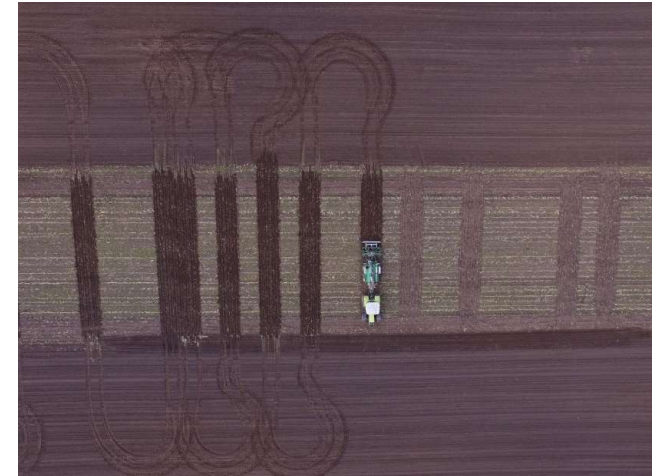
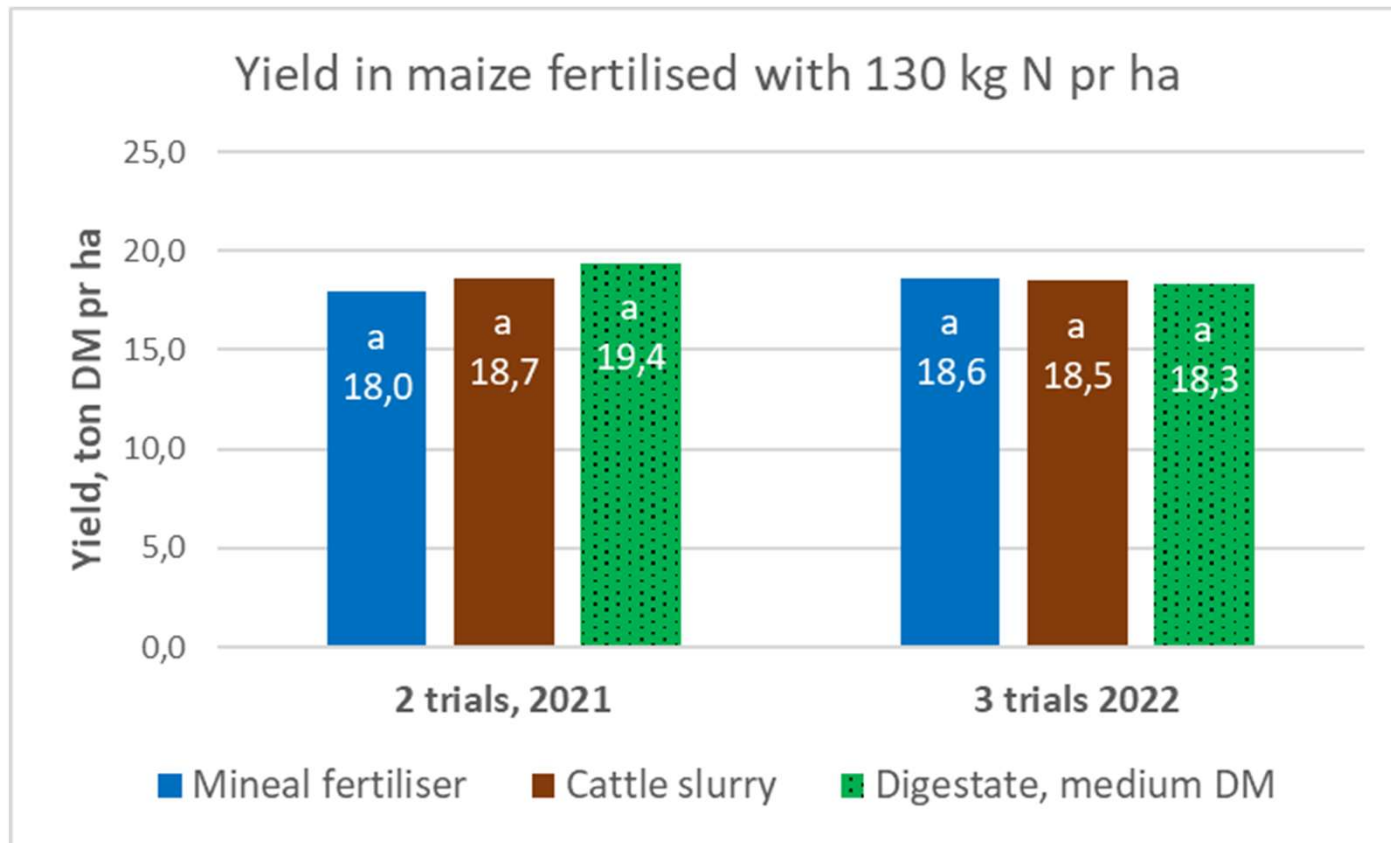
Hafner et al, Aarhus  
University, 2021



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



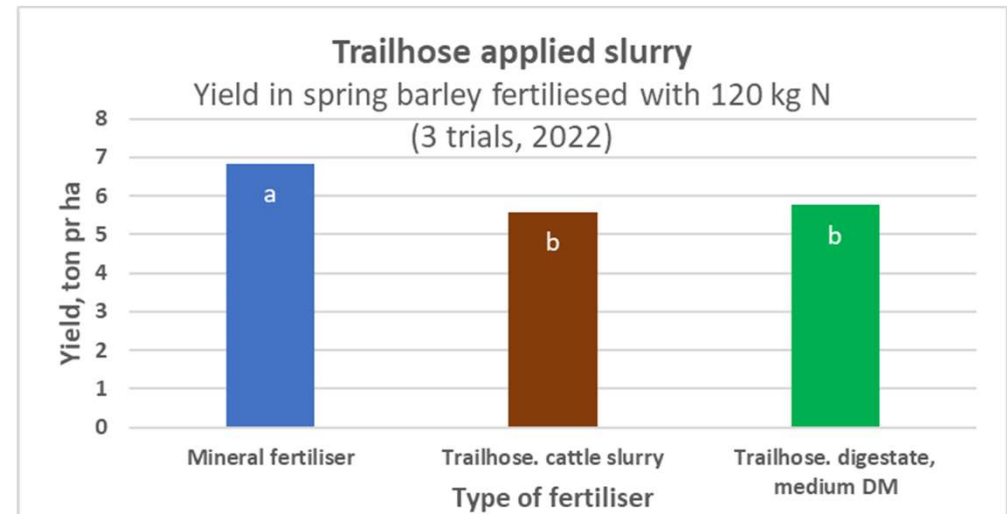
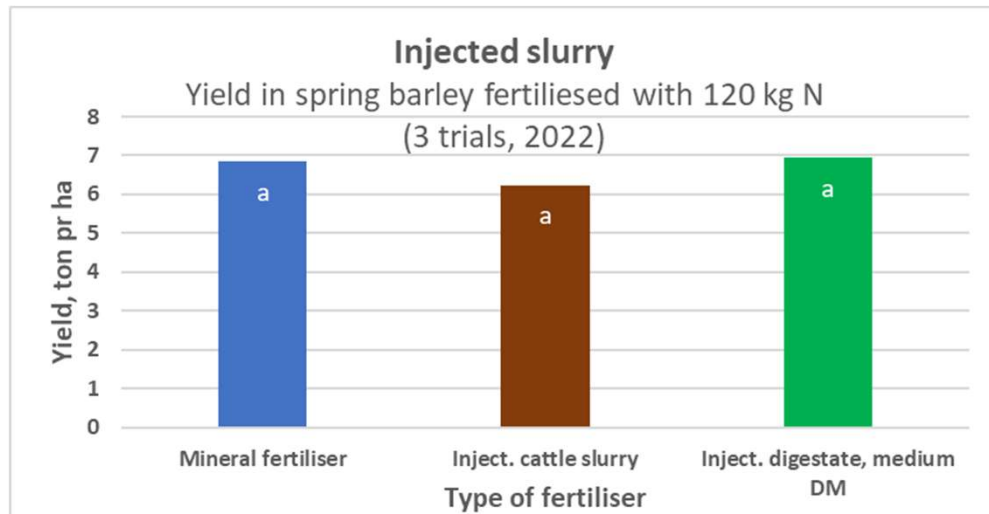
## Soil injected digestates have the same fertilisation effect as mineral fertiliser and cattle slurry in maize



INNOVATION



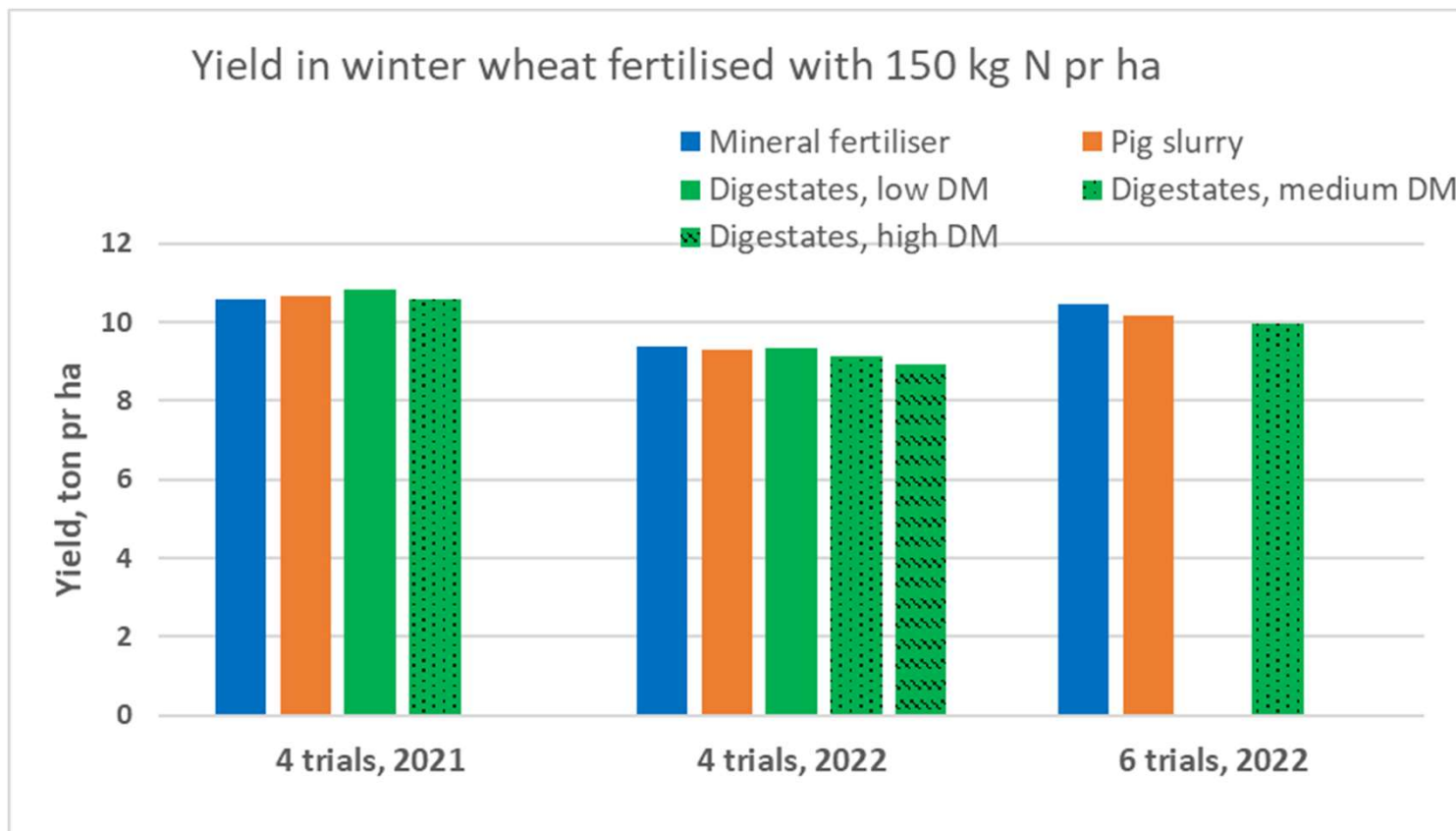
# The nutrient effect of digestates is depending on application time and application technology in spring barley





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

- However, the nutrient effect is depending 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

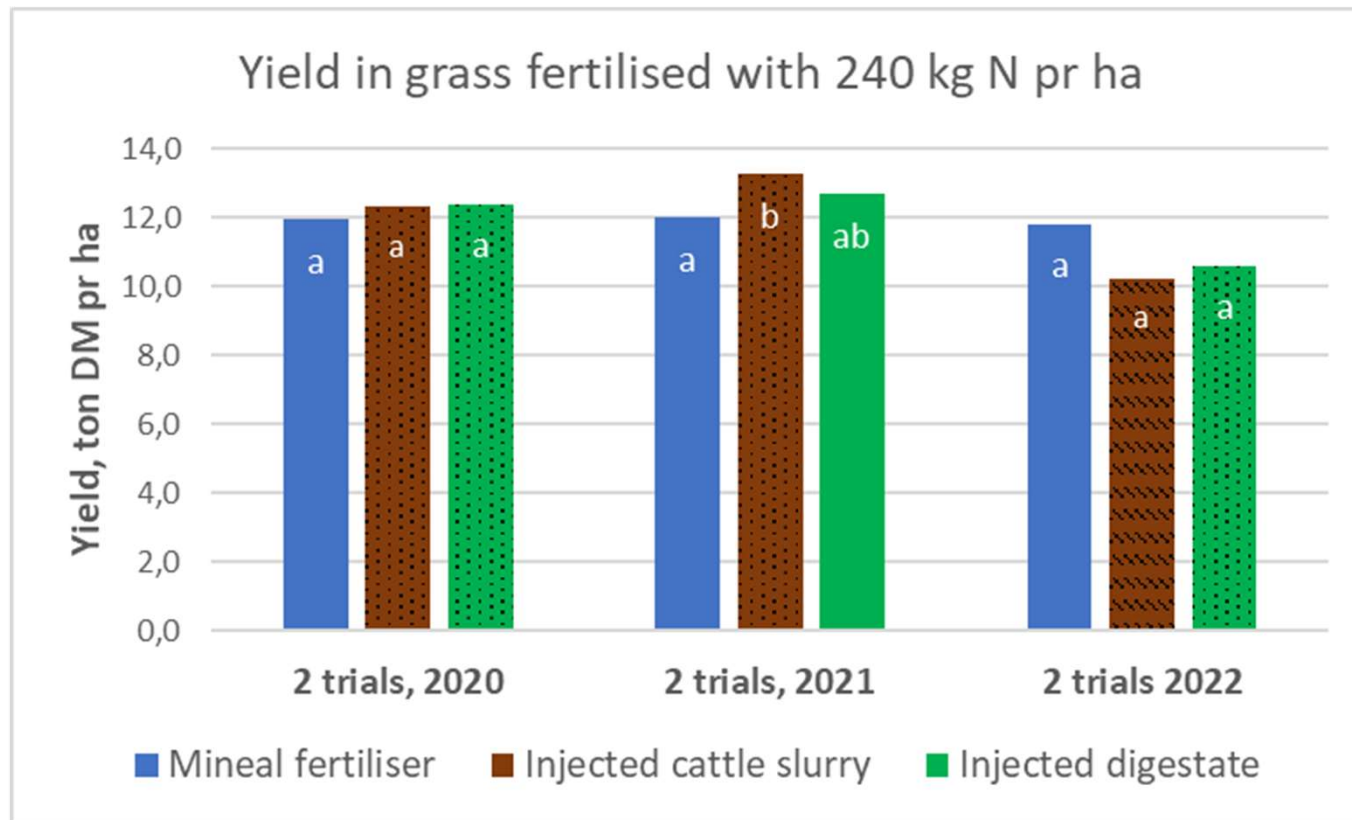


The higher dry matter content of the digestates, the higher loss of nitrogen by ammonia emission from surface applied slurry



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