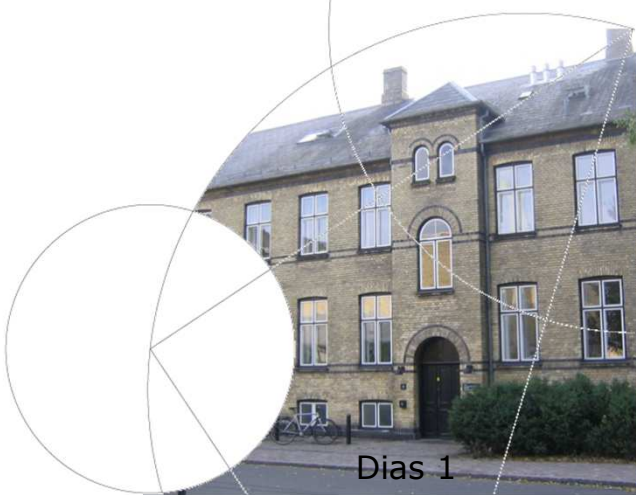
The climate impact (carbon footprint) of pork production

CPH Pig seminar, January 27 2022

Bjarne Bjerg
Department of Veterinary and Animal Sciences



The term carbon footprint

- *is calculated in carbon dioxide equivalent (CO_{2e})*
- *means the total amount CO_{2e} originating from emission of:*
  - *carbon dioxide (CO_2),*
  - *methane (CH_4),*
  - *nitrous oxide (N_2O),*
  - *hydrofluorocarbons (HFCs),*
  - *perfluorocarbons, (PFCs) and*
  - *sulphur hexafluoride (SF_6)*
- *relates to a defined population, system or activity,*
- *consider all relevant sources, sinks and storage within the spatial and temporal boundary of the population, system or activity of interest.*

E.g. production or consumption of pork

Contributions to the carbon footprint from pork

Land Use change, LUC

E.g. LUC_{direct}[1] or $LUC_{indirect}$[2]

[1] Based on the premise that the negative effects of LUC is related only to crops grown on areas that have newly changed from forest to crop production.

- Estimated as the expected degeneration of the of carbon stored in and on the concerned soil.
- Eg ~ 2 kg CO_{2e} m^{-2} $year^{-1}$*

[2] Based on the premise that all crops contribute to the demand for land:

- Related to all crops
- Eg ~ 0.14 kg CO_{2e} m^{-2} $year^{-1}$*

*Estimated from figures stated by:

Mogensen et al,. DCA RAPPORT NR. 116

Agriculture

Feed

Methane emission from manure management

Methane emission directly from the pigs

Energy use on the farm

Laughing gas emission from manure management

After the pigs have left the farm[3]

Transport

Processing (Slaughter[4])

Packing

Retail

[3] Size indications based on:
The Big climate Database
https://denstoreklimadatabase.dk/
Newly published by
Concito, Denmark's Green Think Tank.

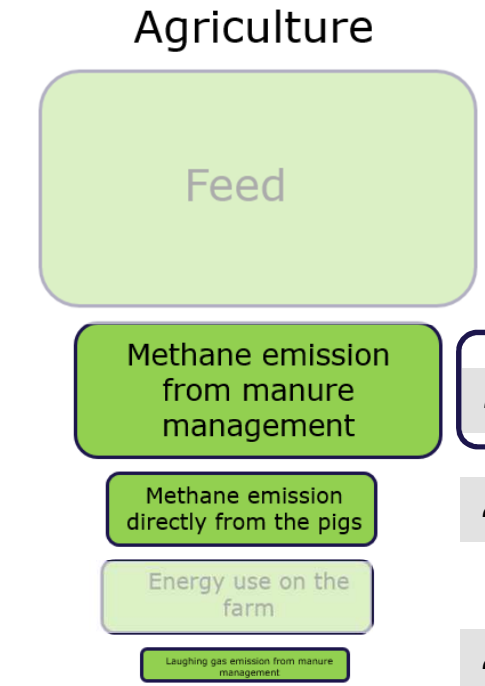
[4] The contribution may be negative because part of the slaughterhouse waste may be recycled and displaces other feed production.

Figures from **The Big Climate Database** https://denstoreklimadatabase.dk/

Published by Concito, Denmark's Green Think Tank.

Food	CO2e pr kg	Agriculture	ILUC	Processing	Packaging	Transport	Retail
Bacon, frying, raw	**4.8**	3.9	0.7	-0.3	0.1	0.4	0.0
Pork, collar with rind, raw	**3.6**	2.8	0.5	-0.2	0.1	0.4	0.0
Pork, collar, defatted, raw	**3.6**	3.2	0.5	-0.4	0.1	0.1	0.0
Pork, flank, spiced, cooked	**3.4**	2.5	0.4	0.3	0.0	0.1	0.0
Pork, ham, boiled, sliced	**3.4**	2.5	0.4	0.3	0.0	0.1	0.0
Pork, ham, topside (M,	**3.6**	2.8	0.5	-0.2	0.1	0.4	0.0
Pork, loin, lean, raw	**4.2**	3.3	0.6	-0.3	0.1	0.4	0.0
Pork, mince, 15-20% fat, raw	**3.0**	2.2	0.4	-0.2	0.1	0.4	0.0
Pork, mince, 5-10% fat, raw	**2.9**	2.5	0.4	-0.3	0.1	0.1	0.0
Pork, saddle, smoked, boiled	**3.4**	2.5	0.4	0.3	0.0	0.1	0.0
Pork, tenderloin, trimmed, raw	**5.4**	4.5	0.8	-0.4	0.1	0.4	0.0
Pulled pork	**3.7**	2.3	0.5	0.2	0.6	0.1	0.0
Pork (simple average)	**3.7**	**2.9**	0.5	-0.1	0.2	0.2	0.0
Soybeans	**1.2**	**0.3**	0.3	0.0	0.2	0.4	0.0
Beef (simple average)	**54.2**	**47.3**	9.1	-2.8	0.2	0.3	0.0
Beef, fillet, defatted, raw	**152.0**	133.5	25.9	-8.1	0.1	0.6	0.0
Beef, low fat	**35.9**	31.9	6.1	-2.4	0.1	0.1	0.0
Beef, mince, 10-15% fat, raw	**32.5**	28.6	5.5	-1.8	0.1	0.1	0.0
Beef, mince, 15-20% fat, raw	**30.8**	26.9	5.2	-1.5	0.1	0.1	0.0
Beef, mince, 5-10% fat, raw	**34.2**	30.3	5.8	-2.1	0.1	0.1	0.0
Beef, rump, raw	**45.7**	39.7	7.7	-2.4	0.1	0.6	0.0
Beef, T-bone steak, raw	**80.9**	70.7	13.7	-4.3	0.1	0.6	0.0
Beef, topside, cap off, raw	**45.7**	39.7	7.7	-2.4	0.1	0.6	0.0
Pulled beef	**38.2**	32.6	6.4	-1.4	0.6	0.1	0.0
Roastbeef, sliced	**45.8**	39.7	7.7	-1.6	0.0	0.1	0.0

Foot print from emissions from the animals and from manure management



~ **0.8 kg CO_{2e} (kg pork)$^{-1}$**

~ **0.2 kg CO_{2e} (kg pork)$^{-1}$**

~ **0.05 kg CO_{2e} (kg pork)$^{-1}$**

Carbon dioxide emission from the animal breath

Not included in normal way to calculate the footprint because it originate from the carbon that is newly captured from the air by photosynthesis in the feed crops

~ **4 kg CO_{2e} (kg pork)$^{-1}$**

Methane and laughing gas emissions is calculated from figures in Denmark´s National Inventory Report 2021 and 2014.

Used assumption:

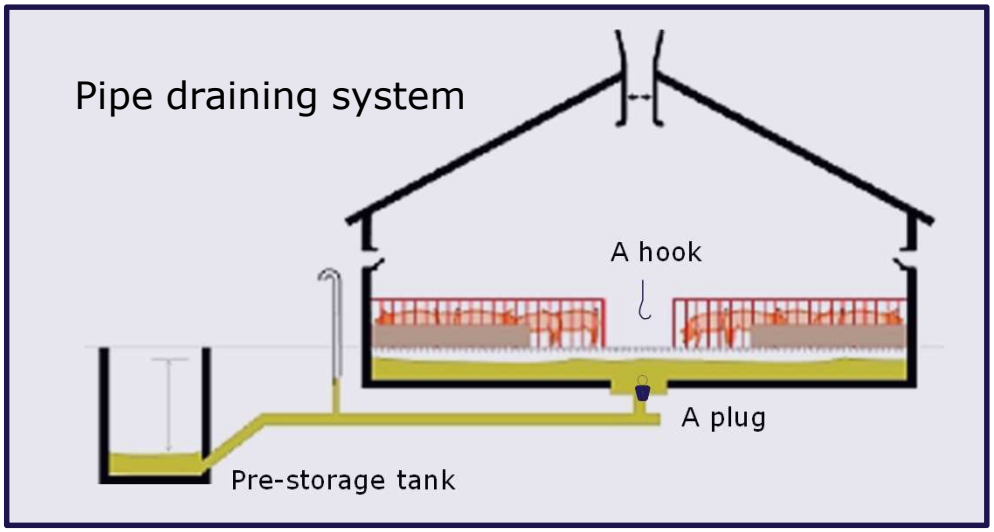
- The average pig used in the report consists of 0.08 sow, 0.50 weaner and 0.42 finisher pig.
- Such a pig produces ~ 225 kg pig year^{-1} (live weight).
- 50 % of live weight is pork.

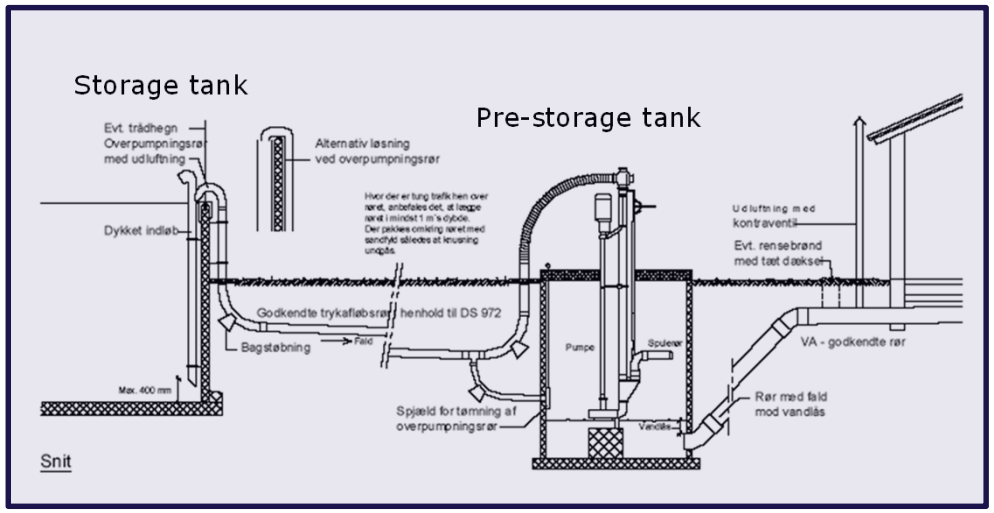
Carbon dioxide emission from the animal breath is estimated by assuming a release of 185 liters of carbon dioxide per hour per heat production. See CIGR 2002: https://www.cigr.org/sites/default/files/documets/CIGR_4TH_WORK_GR.pdf

Manure management:

- Pipe draining is the dominant manure management system in Danish pig production
- The traditional procedure is to drain the manure every four to six weeks.
- It will probably in most cases be possible to drain the manure every week.

At intervals of a few weeks, the farmer lifts a plug in the inlet to the pipe system, and the manure becomes drained to a pre-tank from which it is safely pumped into a slurry tank. The purpose of keeping the inlet to the pipe system closed in the intervening period is to avoid the deposition of solid particles which will eventually fill up the slurry pit and block the system.





The methane emission from liquid manure can be reduced by reducing:

- the amount of manure where from the emission is released to the environment,
- the solid matter content in the manure,
- the temperature in the manure
- the pH in the manure

The Danish Government's climate plan suggests **More frequent draining of the manure** as a requirement. It;

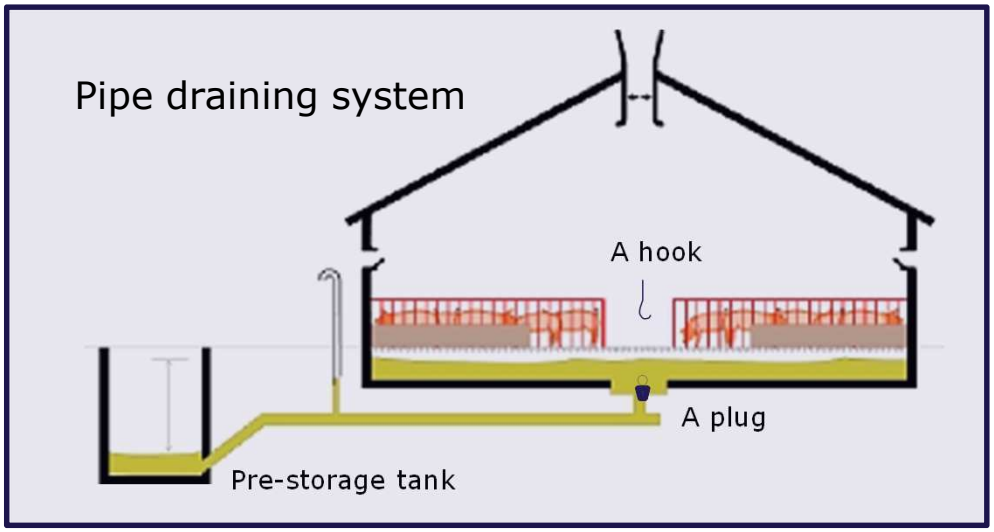
- reduces the amount manure in housing system
- reduces the average temperature of the manure
- require no investment
- is expected to contribute with

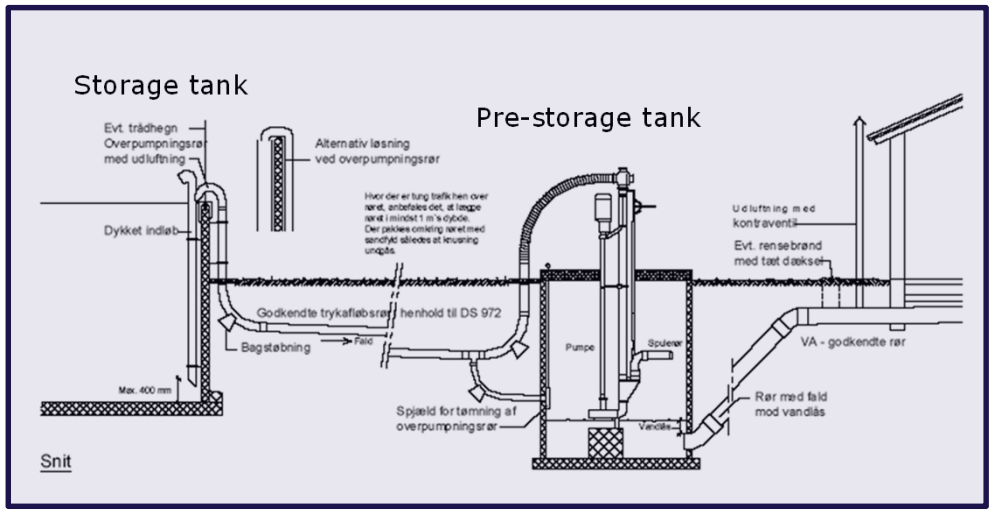
0.1 kg CO_{2e} (kg pork)$^{-1}$

Manure management:

Methods that can reduce methane emission:

- More frequent draining of the manure





The methane emission from liquid manure can be reduced by reducing:

- the amount of manure where from the emission is released to the environment,
- the solid matter content in the manure,
- the temperature in the manure
- the pH in the manure

The Danish Government's climate plan suggests **More frequent draining of the manure** as a requirement. It;

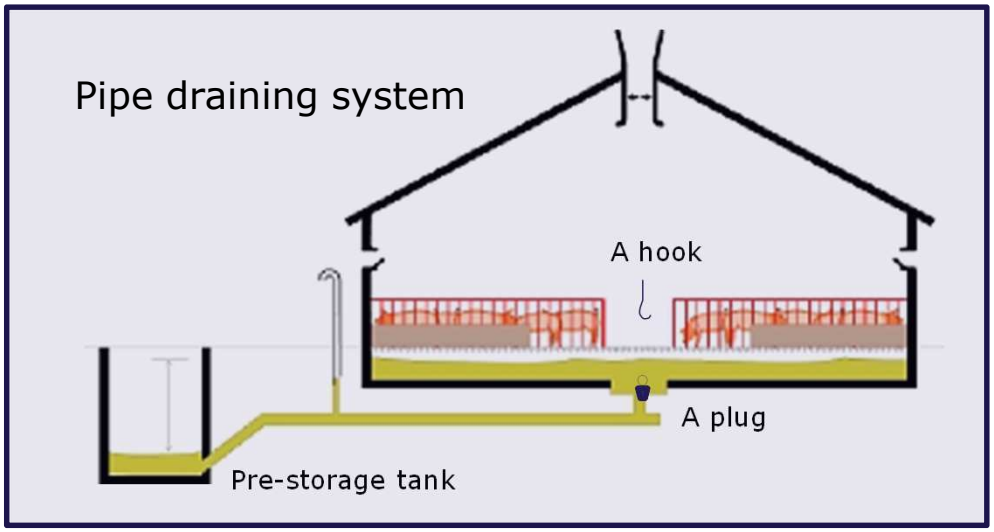
- reduces the amount manure in housing system
- reduces the average temperature of the manure
- require no investment
- is expected to contribute with

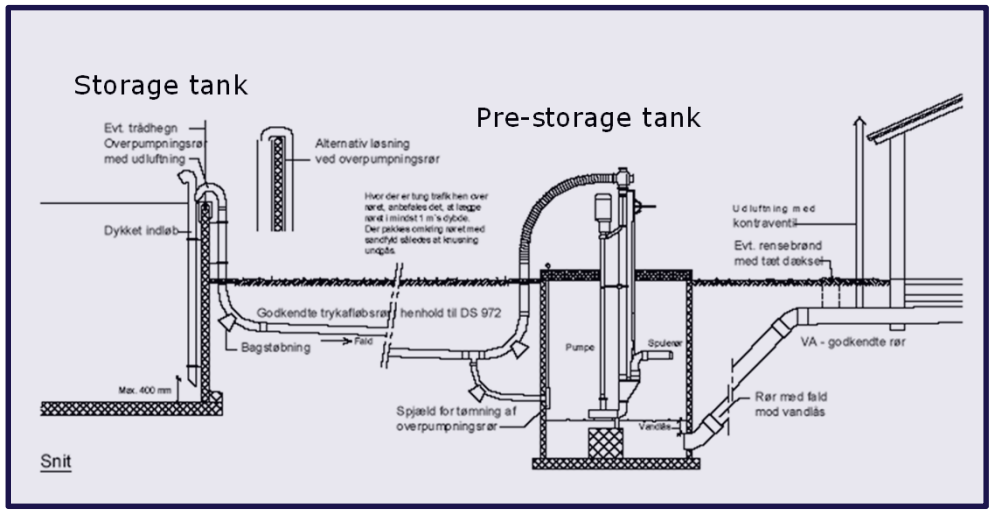
0.1 kg CO_{2e} (kg pork)$^{-1}$

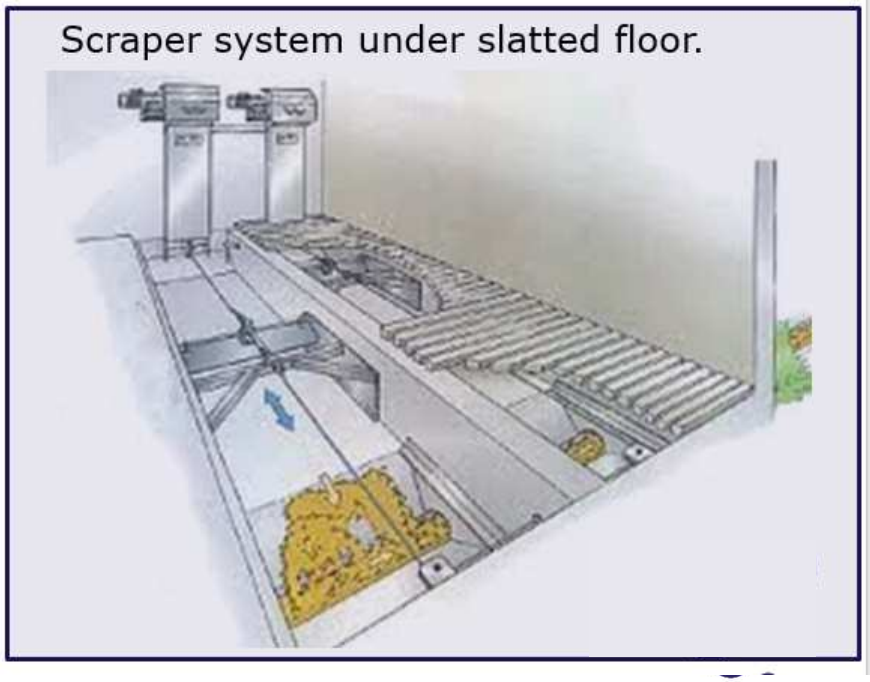
Manure management:

Methods that can reduce methane emission:

- More frequent draining of the manure
- Use of scrapers in the slurry pit
- Reducing the area with drain floor
- Cooling the slurry pit



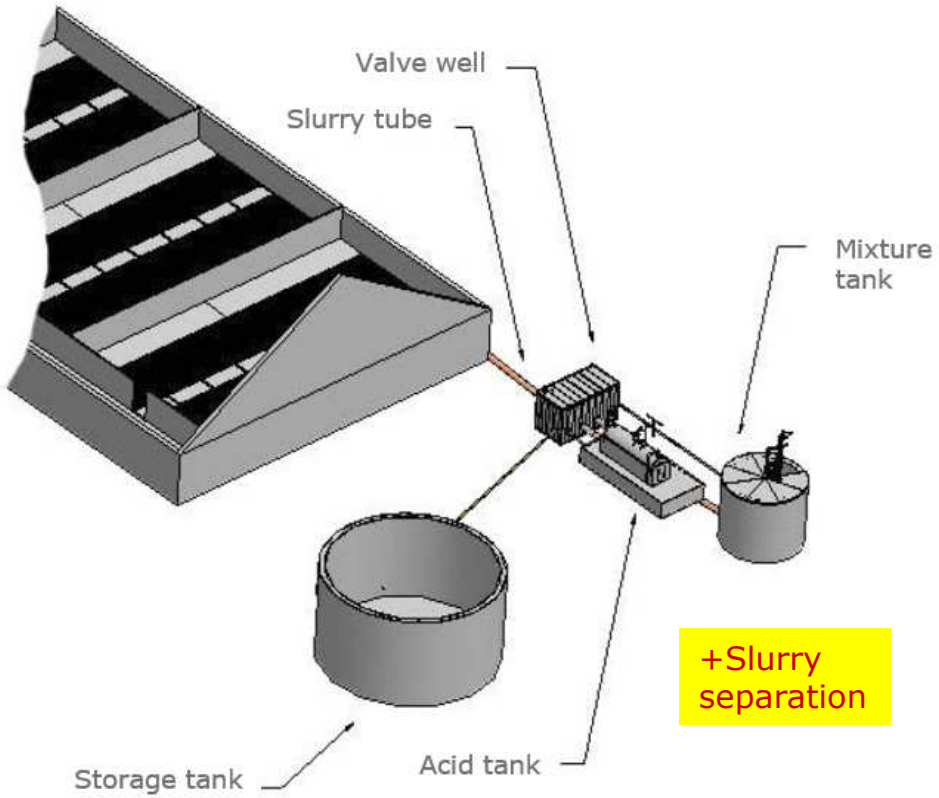




Manure management:

Methods that can reduce methane emission:

- More frequent draining of the manure
- Use of scrapers in the slurry pit
- Reducing the area with drain floor
- Cooling the slurry pit
- Acidification of the manure
- Reduction of solids in manure
- Storage of manure in closed containers --> Biogas



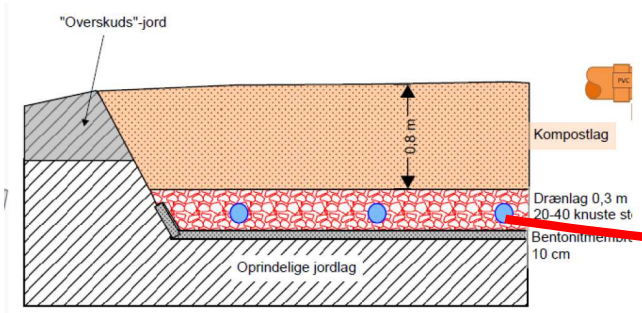
Manure management:

Methods that can reduce methane emission:

- More frequent draining of the manure
- Use of scrapers in the slurry pit
- Reducing the area with drain floor
- Cooling the slurry pit
- Acidification of the manure
- Reduction of solids in manure
- Storage of manure in closed containers --> Biogas
- Storage of manure in closed containers --> Covered slurry tanks with control air flow in the headspace above the manure, and cleaning of extracted air.

Good potentials exits to reduce methane emissions from manure management.

Currently it constitute ~ 20 % of the footprint of pork.



Biofilters are frequently use to degrade methane from land fills.

My current view on the carbon footprint of pork:

- The carbon footprint of pork can probably reduced by ~ 50 % to

  ~ 2 kg CO_{2e} (kg pork)$^{-1}$.

- Replacement of 1 kg pork by 0.5 kg of soybeans will give approximately the same amount of nutrients, but reduce the carbon footprint by **~ 1.5 kg CO_{2e}.**

We might miss something:

- Feed crops to produce 1 kg pork occupy an area of 8 m^2 in a year.
- Production of 0.5 kg soybeans occupy an area of 1.5 m^2 in a year.
- Replacement of 1 kg pork by 0.5 kg of soybeans release an area of 6.5 m^2 in a year.
- If 6.5 m^2 is planted with willow then there may be harvested 8 kg of biomass dm $year^{-1}$.
- The carbon in 8 kg biomass corresponds to capture of **15 kg CO_2** from the air.
- The harvested biomass may be stored or converted to aviation fuel.
- Therefore it can be argued that the **15 kg CO_2** should be added to the carbon footprint of one kg pork.

Assumption:

- The carbon footprint from soybeans can be reduce by ~ 15 % to ~ 1 kg CO_{2e} (kg soybeans)$^{-1}$
- Feed to produce 1 kg pork consists of 4 kg grain and 1.2 kg soymeal.
- Yield for crops in kg m^{-2}: grain: 0.8, soybeans: 0.3 and soymeal: 0.2.
- Relative value of soymeal in relation to the value of the entire bean: 60 %. (accounts for that soymeal is less valuable than soy oil).
- Willow biomass dry matter harvest of 1.2 kg m^{-1} $Year^{-1}$. Ref: Larsen et al,. 2014. Long-term yield effects of establishment method and weed control in willow for short rotation coppice (SRC). Biomass Bioenergy 71, 266-274.
- Carbon constitutes 50 % of willow biomass dry matter.

thank you for attending