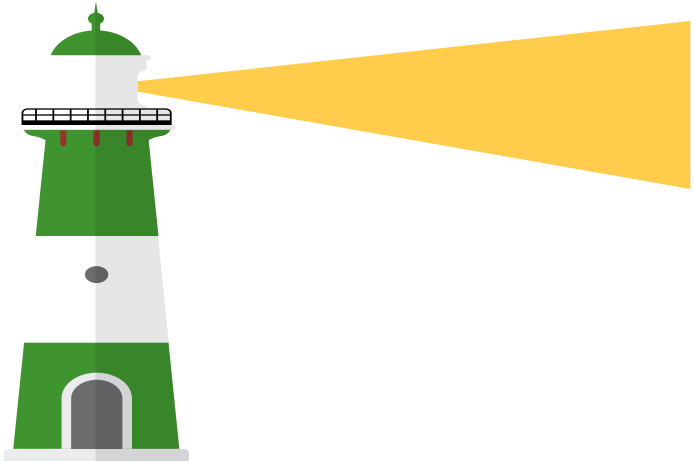
Nutri2Cycle

Transition towards a more carbon and nutrient efficient agriculture in Europe



Adapted stable construction for separated collection of solid manure and urine in pig housing (followed by separate post-processing)

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773682.

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VERMEULEN DOBBELAERE WELFARE SYSTEM SUSTAINABLE LOW EMISSION STABLE

VeDoWs

INNOVATION

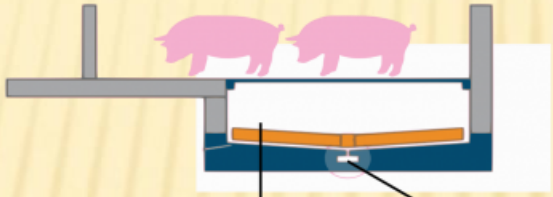
- Development and application of a new stable system
- Application: porkers and sows (gestating and breeding)
- Immediate phase separation between solid and liquid fractions
- Preventing the formation of ammonia and other odorous gases
- Sustainable with attention to:
  - Energy and water consumption
  - Manure is regarded as a recource instead of waste
  - Improving living conditions for people and animals
  - Infection pressure
  - Current issues such as greenhouse gas emissions

VERMEULEN DOBBELAERE WELFARE SYSTEM
DUURZAAM EMISSIEARM SYSTEEM

PIG MANURE

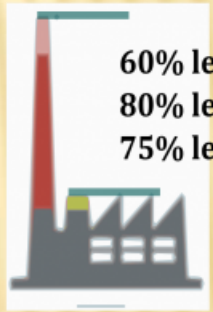
VeDoWs stable
(BBT België-
Emissie arm stalsysteem
voor vleesvarkens en zeugen)

Biogas potentieel
280-400 Nm^3/ton DS



Solid fraction

Liquid fraction (Urine)



60% less NH3
80% less CH4
75% less Odour Units

Principle and Design

Concrete structure consisting of:
Floor with 3% slope
Central urine slot
Underlying urine channel
Mechanical manure scraper

MEASUREMENT DURING TWO FATTENING PERIODS

Ventilation

Odour sampling

Gasanalyser:
NH3, CH4, N2O, CO2

RESULTS:

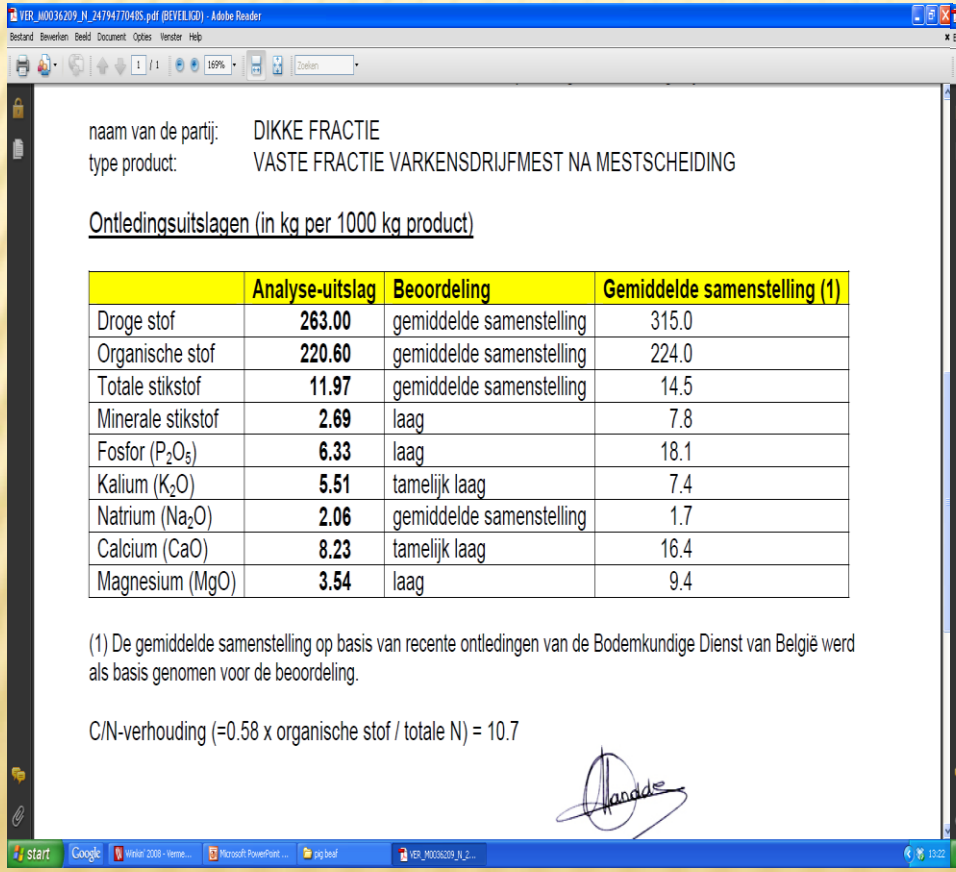
Porkers (V4.8)	
Component	Emission reduction (%)
Ammonia	60
Methane	60
Odour	75

Sows (V3.9 and V3.10)	
Component	Emission reduction (%)
Ammonia	60
Methane	60
Odour	50

ANALYSIS AND APPLICATIONS

SOLID FRACTION BIOGAS

URINE FERTILIZER 50 T/HA



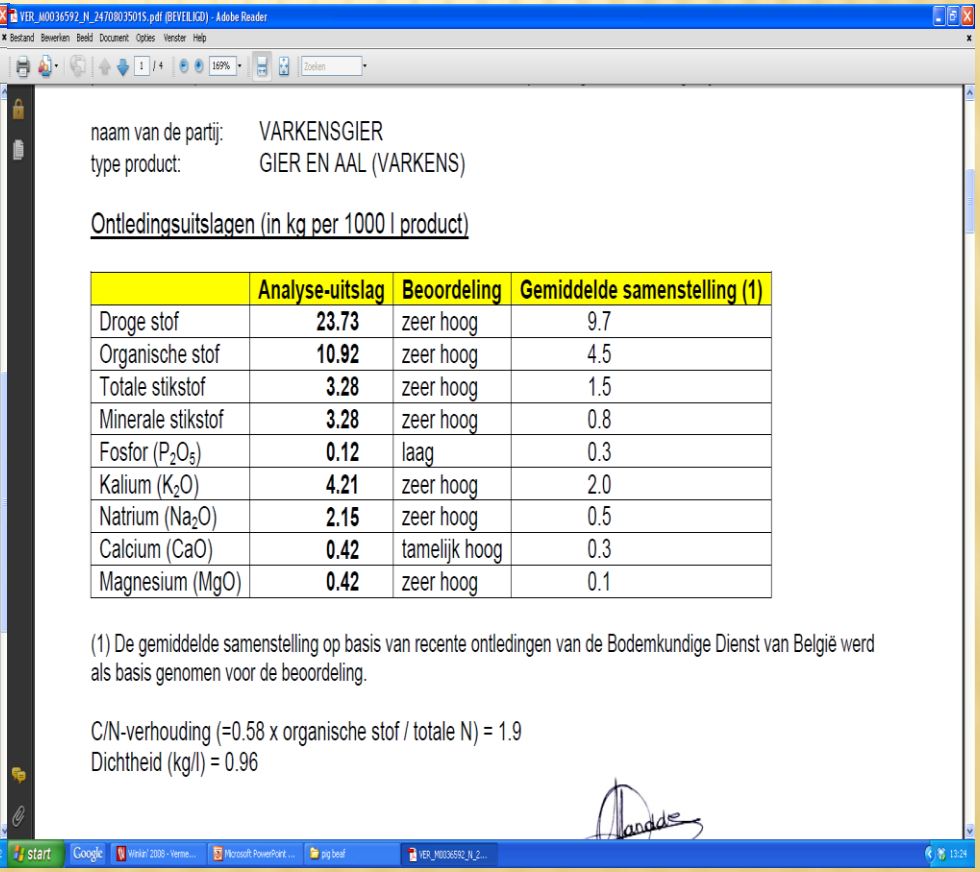
naam van de partij: DIKKE FRACTIE
type product: VASTE FRACTIE VARKENSDRIJFMEST NA MESTSCHEIDING

Ontledingsuitslagen (in kg per 1000 kg product)

	Analyse-uitslag	Beoordeling	Gemiddelde samenstelling (1)
Droge stof	**263.00**	gemiddelde samenstelling	315.0
Organische stof	**220.60**	gemiddelde samenstelling	224.0
Totale stikstof	**11.97**	gemiddelde samenstelling	14.5
Minerale stikstof	**2.69**	laag	7.8
Fosfor (P_2O_5)	**6.33**	laag	18.1
Kalium (K_2O)	**5.51**	tamelijk laag	7.4
Natrium (Na_2O)	**2.06**	gemiddelde samenstelling	1.7
Calcium (CaO)	**8.23**	tamelijk laag	16.4
Magnesium (MgO)	**3.54**	laag	9.4

(1) De gemiddelde samenstelling op basis van recente ontledingen van de Bodemkundige Dienst van België werd als basis genomen voor de beoordeling.

C/N-verhouding (=0.58 x organische stof / totale N) = 10.7



naam van de partij: VARKENSGIER
type product: GIER EN AAL (VARKENS)

Ontledingsuitslagen (in kg per 1000 l product)

	Analyse-uitslag	Beoordeling	Gemiddelde samenstelling (1)
Droge stof	**23.73**	zeer hoog	9.7
Organische stof	**10.92**	zeer hoog	4.5
Totale stikstof	**3.28**	zeer hoog	1.5
Minerale stikstof	**3.28**	zeer hoog	0.8
Fosfor (P_2O_5)	**0.12**	laag	0.3
Kalium (K_2O)	**4.21**	zeer hoog	2.0
Natrium (Na_2O)	**2.15**	zeer hoog	0.5
Calcium (CaO)	**0.42**	tamelijk hoog	0.3
Magnesium (MgO)	**0.42**	zeer hoog	0.1

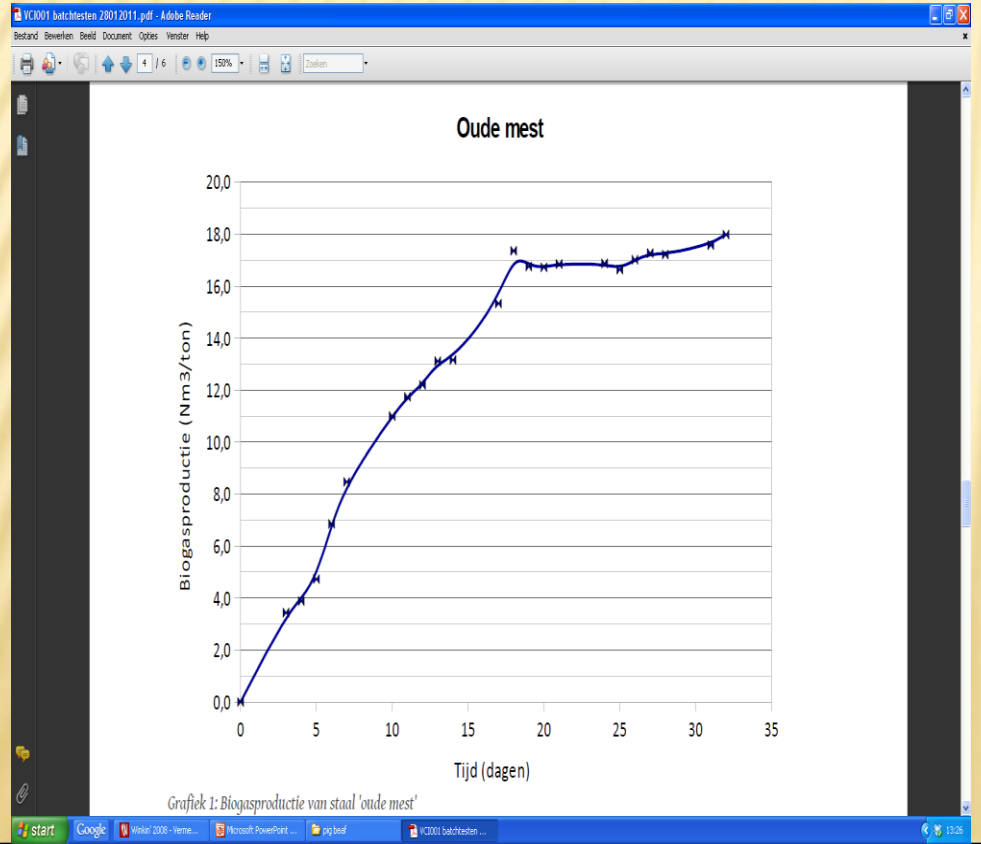
(1) De gemiddelde samenstelling op basis van recente ontledingen van de Bodemkundige Dienst van België werd als basis genomen voor de beoordeling.

C/N-verhouding (=0.58 x organische stof / totale N) = 1.9
Dichtheid (kg/l) = 0.96

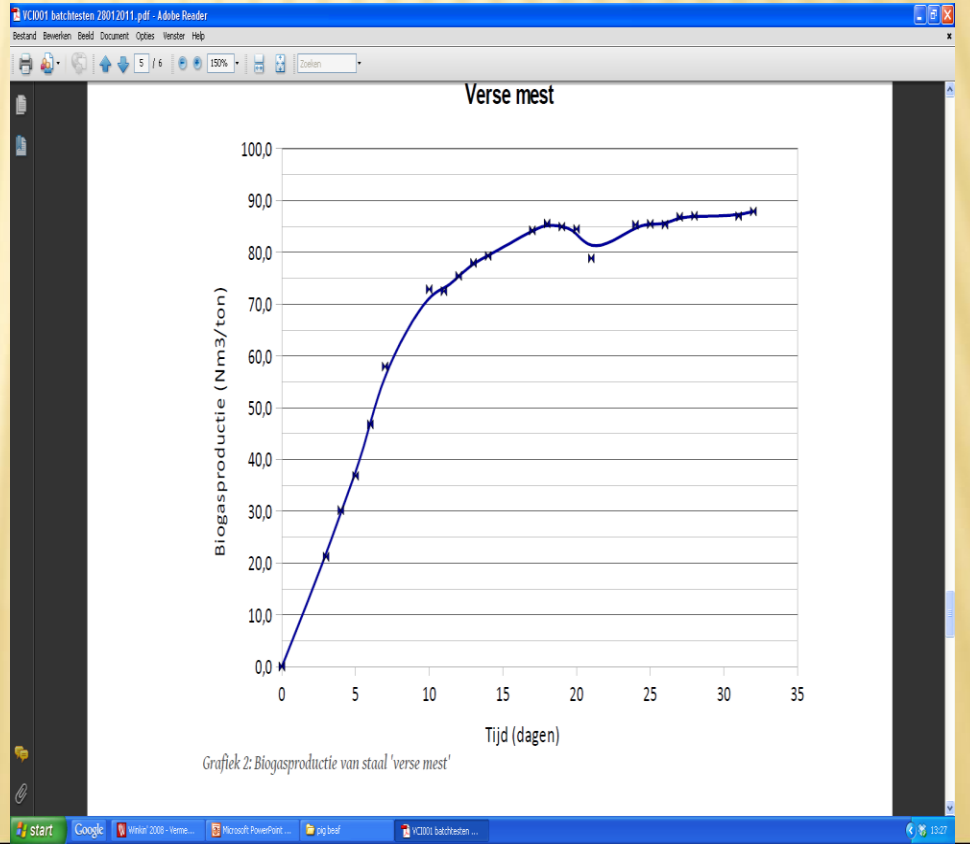
BIOGAS YIELD

CH4: 55-60%
2 MAANDEN 28%DM

60-65%
7 DAGEN 25%DM



Grafiek 1: Biogasproductie van staal 'oude mest'



Grafiek 2: Biogasproductie van staal 'verse mest'

SPECIFIC BIOGAS YIELD

	Manure Pit	VeDoWs
Biogas Yield ($nm^3/t_{dry\ manure}$)	65	300
Biogas energy density (kWh/nm^3)	6.5	6.5
Energy yield ($kWh/t_{dry\ manure}$)	422.5	1950

- One pig place produces 120 kg dry manure annually
- Results show VeDoWs manure is favourable for anaerobic digestation

CONCLUSION

- Reduction in ammonia, odour, methane and dust
- Emission prevention instead of reduction
- Lower water and energy consumption compared to end-off-pipe techniques
- Anaerobic digestation of the solid fraction
- Liquid fraction as potassium fertilizer
- Improved working and livingconditions
- Reduction in insects
- Lower infection rates

THANK YOU FOR YOUR ATTENTION

Vermeulen Geert
0475/410732

VeDoWs technology: emissions

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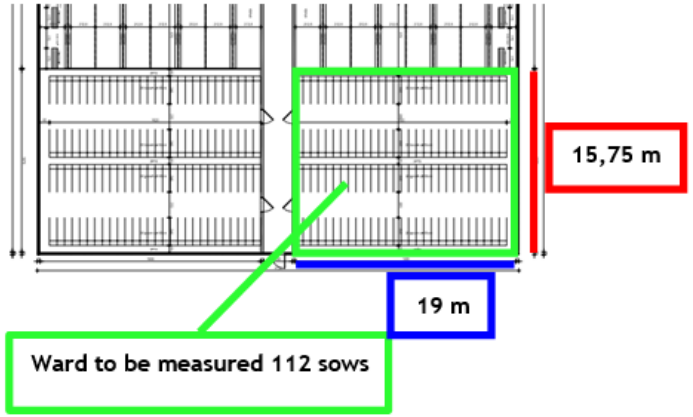
- Measurement campaign: Comparing traditional pig housing vs VeDoWs (2019)
- Dimensions (measurement compartment): 15,75 m x 19 m, ca. 300 m² or ~ 2,67 m²/animal place



Traditional pig housing		VeDoWs source separation system
84.08	OU_E/s. animal	10.10
5.33	kg CH_4/ animal place. year	3.64
4.2	kg NH_3/ animal place. year	0.77

87-88% reduction in odour

31% reduction in methane emissions

81% reduction in ammonia emissions

VeDoWs technology: product characterization

Nutri2Cycle

Parameter	Unit	VeDoWS manure	Pig slurry	VeDoWs urine
pH		7.24 ± 0.43 (6.57 -7.30)	7.63±0.03	8.7
Ammonium N	g NH_3-N/kg fresh matter (FM)	1.53±0.40	2.79±0.29	5.1 ± 0.05
Total N	g/ kg FM	10.23±0.21	4.63±0.82	6.1
Mineral N	g/ kg FM	1.53±0.41	2.80±0.29	5.1 ± 0.05
Kjeldahl N	g/ kg FM	10.29±0.21	4.62±0.83	6.1
Potassium	g/kg K_2O FM	3.49±3.49	4.46±0.99	3.5 ± 0.09
Phosphorus	g/kg P_2O_5 FM	8.89±0.06	2.97±0.84	<0.00038
Dry matter	%	25.5±8.8 (15.87-33.84)	6.1±1.8	2.2 ± 0.02
Total Carbon	g/ kg FM			6.8
Organic Carbon	g/ kg FM	117.70±4.2	25.68±7.58	
Organic matter	g/ kg FM	211.86±7.55	46.22±13.64	7.92
Conductivity	mS/cm	6.11±0.3	23.42±1.64	48
Biogas potential[1]	M^3 biogas/tonne	135±7 (61.6 -149.0)	15±1	
Methane content	%	58±0 (61.8 – 66.4)	57±0	
Methane potential	M^3CH4/tonne	78±4 (40.5 – 88.7)	9±0	
Biogas potential[2]	M^3 biogas/tonne	157.1 (rt = 42)	33.2 (rt = 42)	

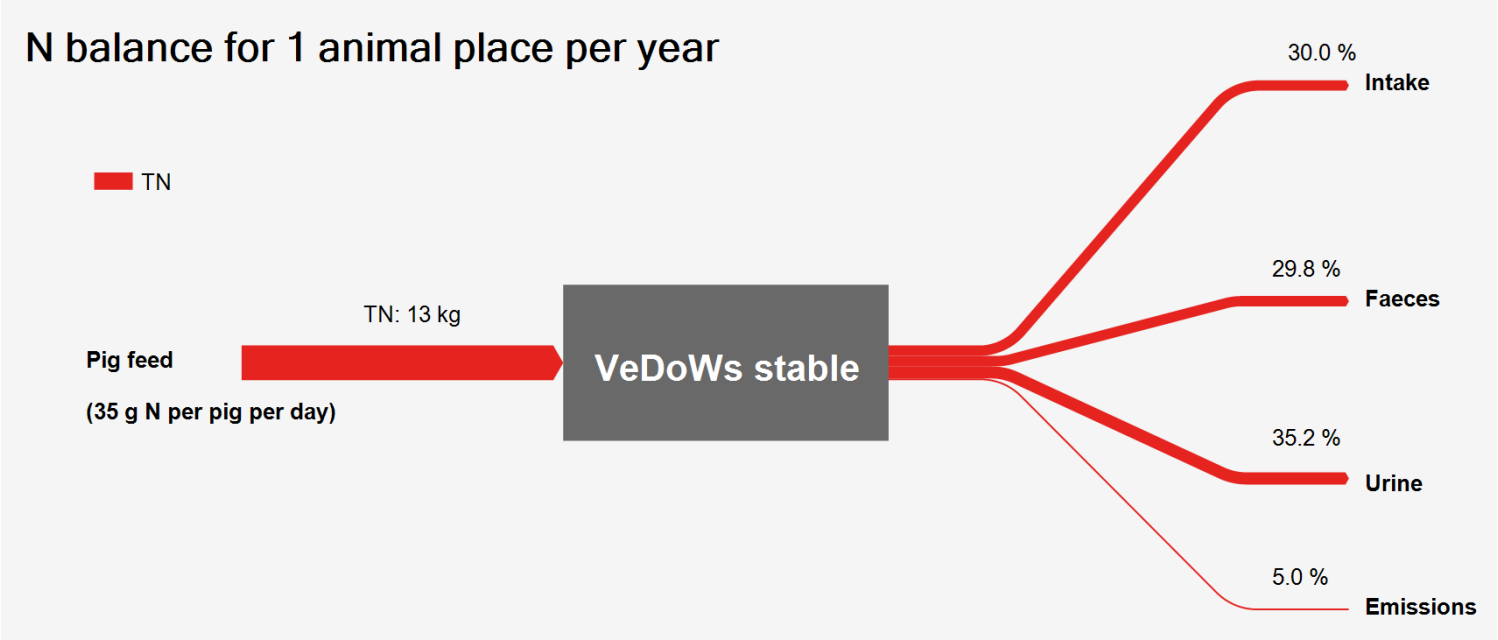
[1] Theoretical calculation based on substrate characterization
[2] Experimental determination in optimal conditions
rt = retention time
In brackets values provided by Vermeulen bvba

Miserez, Bockstael, Fernandes De Souza, 2021. Co-digestion of roadside grass with VeDoWS manure and pig slurry. Grassification project.

Saju, Harms, Postma, Lagrange, Deinert, Sigurnjak, Meers, 2021. Report on mineral nutrient composition of analysed recyling-derived fertilizers. ReNu2Farm project.

VeDoWs technology: nitrogen flow

Nutri2Cycle



VeDoWs system: LCA

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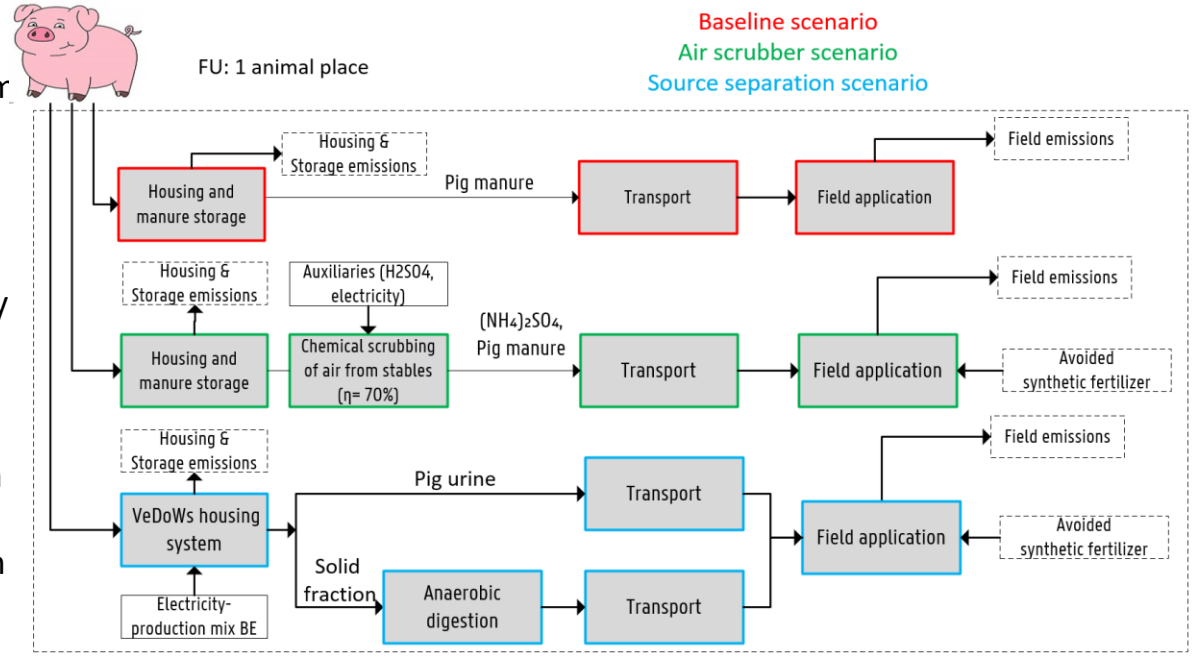
System boundaries

- Goal: Comparing emissions abatement at pig housing systems and downstream impacts of products
- Functional unit: 1 animal place
- **Baseline**: Traditional pig housing (slurry pit under animal place) and field application of PM
- **Source separation scenario**: VeDoWs separation system and field application of pig urine & digested solid fraction
- **Air scrubber scenario:** Pig housing with air scrubbers and field application of Ammonium sulate and PM



Contribution analysis

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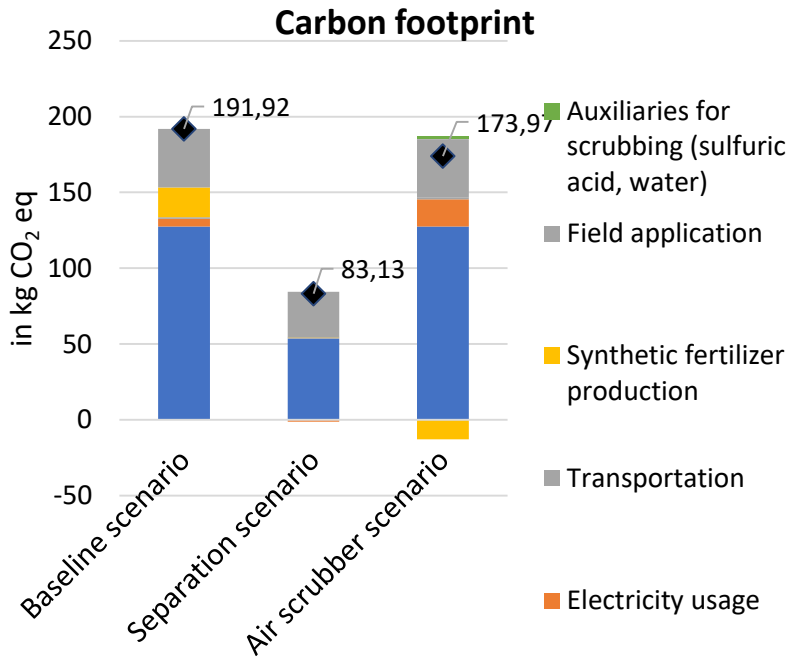

3-year field trial: setup

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- Location of trial : Wingene, West Flanders
- Test-crops : Maize (2019), Spinach (2020), Potatoes (2021)
- Treatments spread across 4 blocks :
  - Ammonium nitrate (N=30%) as the synthetic reference,
  - Pig slurry as the organic reference,
  - pig urine (n=4),
  - an unfertilised control and
  - PK control (n=8) spread across 4 blocks
- N advice: for maize 151 kg N ha^{-1}; for spinach and potatoes 210 kg N ha^{-1}
- Incremental N dosages applied : optimal -30%, optimal -70% and optimal N
- Most important parameters assessed:
  - Fresh and dry yield of plants
  - Nitrogen fertiliser replacement value (NFRV)
  - Residual soil nitrate content

Figure *Custom-made fertiliser machine used in field trial (above). Incorporation of fertilisers into top-soil layer (below).*

Conclusion

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- Using a source-based technique, i.e. manure segregation helps in reducing the carbon footprint by a factor of 2, relative to the end-of-pipe technique i.e. air scrubbers. (*However, this hinges on the condition that the faeces fraction is immediately transported to a biogas plant for further processing. Farms without their digester or farms which transport the faeces fraction over large distances would have a higher carbon footprint)*

- Pig urine has potential to be used as a N fertilizer, and solid fraction from VeDoWs system can be used as a feedstock for AD

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