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Odour emissions impact of on-farm biogas production with co-digestion : a case study in four European farms of the Great Region

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Photo: James Arthur

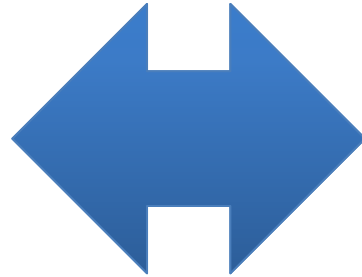
Assessing odor nuisance is a complex science

Aim of the study

Comparing the odor impact of agricultural biomethanation plants with classical farms

- Evaluating odor emissions fluxes from various materials and detecting critical materials
 - Assessing odor annoyance in the surroundings
- } Farm level
- Comparing odor emissions in land application conditions of digested and untreated organic material
- } Land level

biogas facility versus traditional farm



Not straightforward

- High variability between farms themselves
- Identical odor sources in both farm types (barns, manure storage, slurry, maize silage)
- Odor nuisance is never due to the biogas itself, because it is produced and transported in closed and airtight circuits
- Large diversity of anaerobic digestion feedstock

Case studies: 4 farms with anaerobic digestion plant



Faascht farm (BE)



230 ha, ± 380 large stock units

Biogas plant: 750 kW

Substrates (18 000 T):

- Food industry waste (54 %)
- Cattle manure/slurry (33 %)
- Maize silage (8 %)

+ **Digestate drying unit**



Biogas Biekerich

Biogas Biekerich (LU)



Centralized agricultural biogas plant

18 farms, 1430 ha, ± 2200 large stock units

Biogas plant: 600 kW

Substrates (32 000 T):

- Cattle manure/slurry (77 %)
- Maize and grass silage (14 %)
- Food industry waste (9 %)

Case studies: 4 farms with anaerobic digestion plant

Biogas Rohlingerhof Biogas Rohlingerhof (DE)



170 ha, ± 140 large stock units

Biogas plant: 250 kW

Substrates (5400 T):

- Maize silage (62 %)
- Cattle manure/slurry (34 %)
- Grass silage (4 %)
- + wood drying unit



Bio-Recycle (FR)



Organic farm, 115 ha, ± 110 large stock units

Biogas plant: 255 kW

Substrates (5500 T):

- Food industry waste (56 %)
- Cattle manure/slurry (38 %)
- Maize silage (6 %)
- + grass drying unit

Measurement toolbox

1. Evaluation of odour annoyance in the surroundings

➔ Different complementary methods

Odor sampling followed by dynamic olfactometry (EN13725 standard) ➔ measuring odor concentration of different sources (ou_E/m^3)



Field inspection + dispersion modeling ➔ assessing global odor emission rate

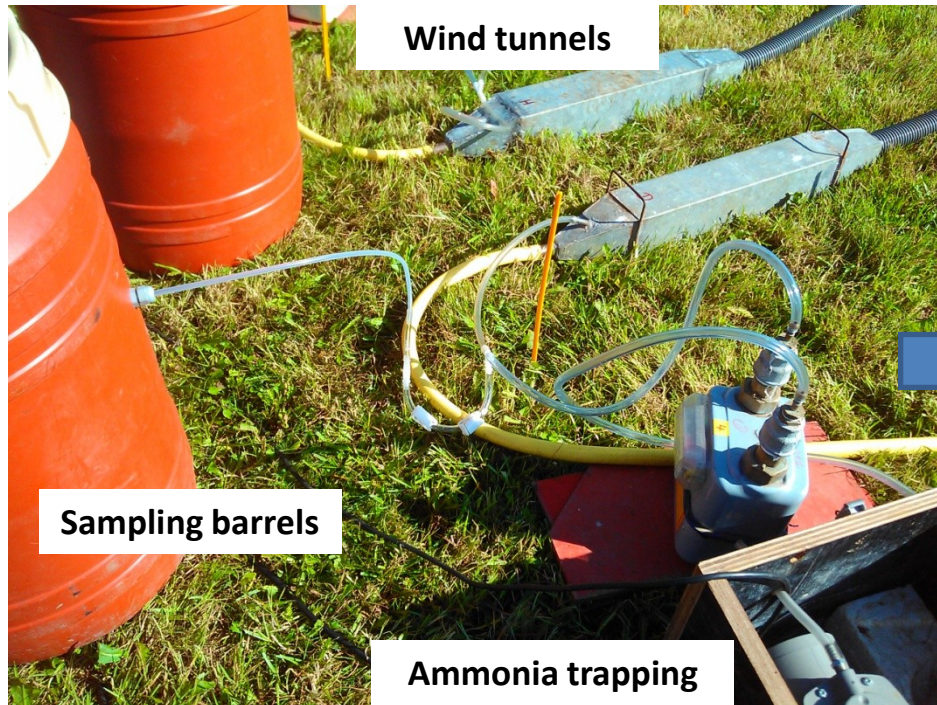
Portable olfactometer (Nasal Ranger) ➔ validating field inspection



Measurement toolbox

2. Evaluation of odour flow rate of land applications for treated/untreated fertilizers

Odor sampling followed by dynamic olfactometry (EN13725 standard) → measuring odor flow rate of different anaerobic digestion by-products applied on the land

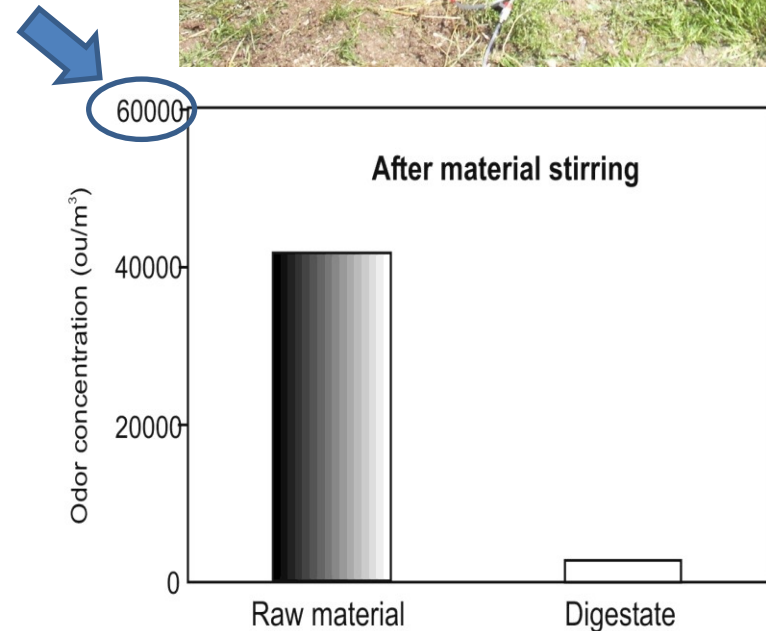
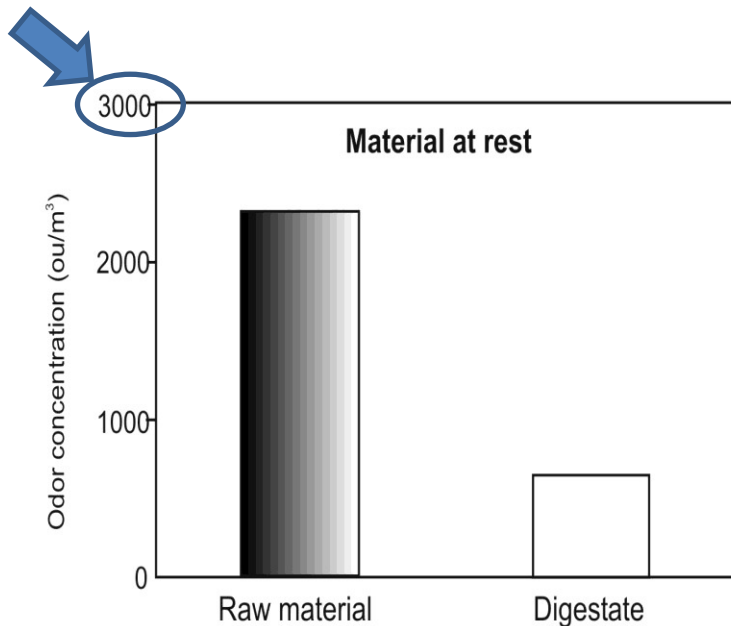


Odor concentration of some sources are critical

<i>Location</i>	<i>farm</i>	<i>Odor concentration (ou_E/m³)</i>
Cattle barn	Palzem	634
Cattle and pig slurry pit	Beckerich	70 230
		283 698
		98 867
		10 935
		6 575
Storage of mixed solid waste (maize, chocolate fabrication by-products, manure)	Faascht	6 640
		86 980
		630
Liquid by-products of food industry	Faascht	533 700
Digestate storage tank	Beckerich	8 493
		5 368
		185
		83
	Faascht	2500
		450
Digestate drying	Faascht	1 371
		914
		602
		729

Care to critical material handling

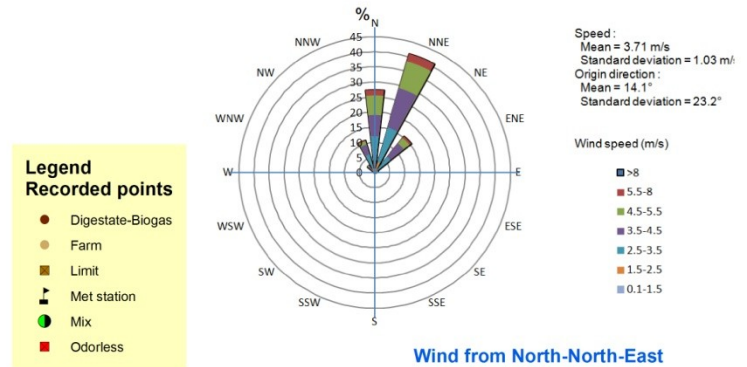
- Significant reduction of the odor concentration in air samples collected above the material between raw slurry/manure and digestate
- Material handling significantly affects odor concentration
- Less odor emissions for digestate handling



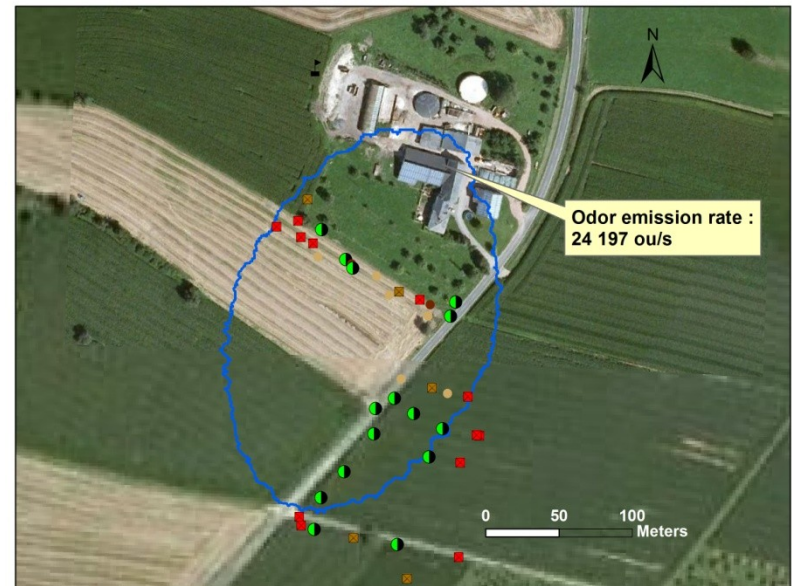
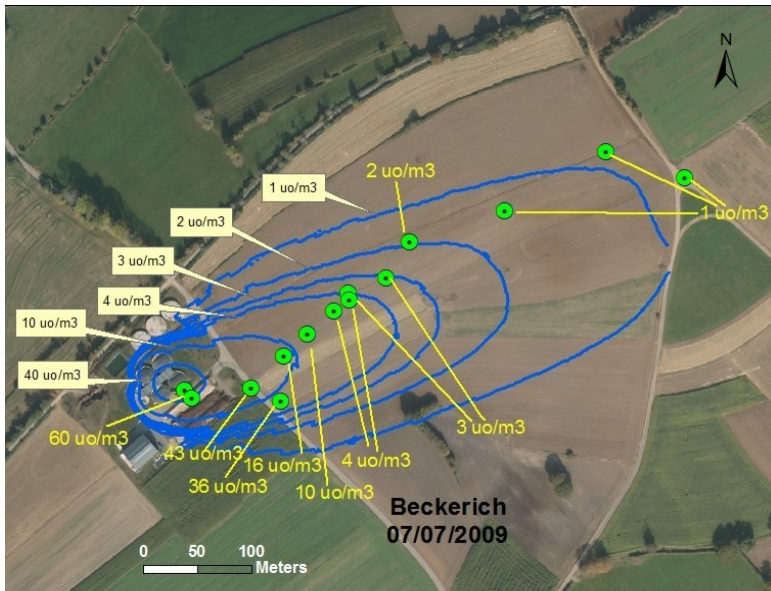
Odor measurements in the surroundings of farms

10 field inspections at Faascht, Beckerich and Palzem (mostly during Summer 2009).
• Odor emission rate deduced from backcalculation using Tropos-Impact model (Odotech)
+ field olfactometer measurements

Field inspection June 23th (Palzem)



Wind from North-North-East
 Pasquill stability class : B



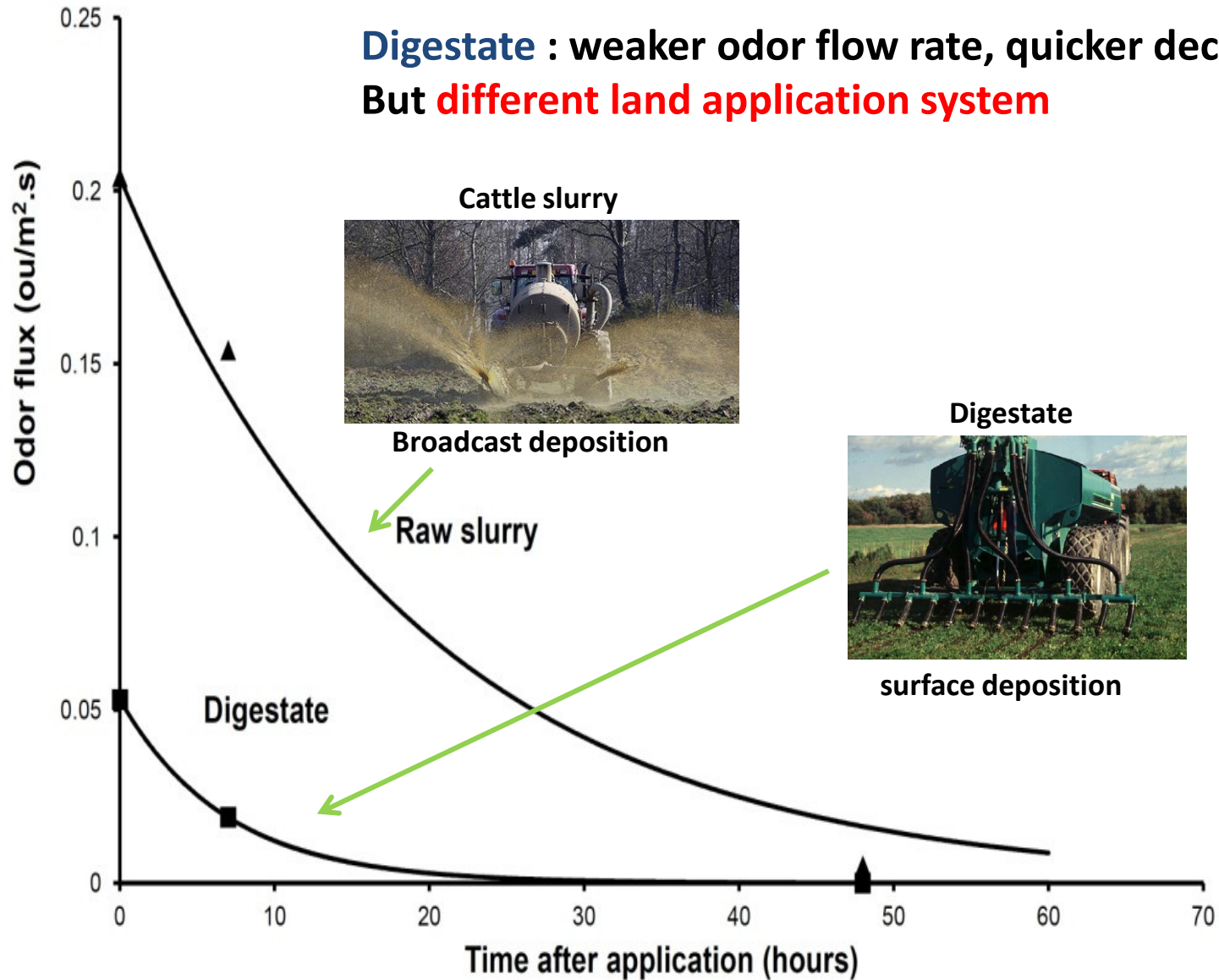
Good agreement between portable olfactometer and field inspection measurements

	Date	Odor emission rate	Maximum perception distance	
Faascht	19/06/2009	79 384 uo/s	600 m	Highly variable , depending on the process (e.g. : digestate drying)
	28/08/2009	10 725 uo/s	250 m	
	10/09/2009	23 553 uo/s	430 m	
Beckerich	05/05/2009	7 306 uo/s	300 m	Mostly manure storage, maize silage + slurry discharge in the pit
	06/07/2009	43 752 uo/s	500 m	
	13/07/2009	10 942 uo/s	300 m	
Palzem	23/06/2009	24 197 uo/s	300 m	Normal "farm" odor + maize silage
	07/07/2009	18 593 uo/s	500 m	

Mean odor emission rate = 20 000 ou/s

"Annoyance" zone (P98 for 1 ou/m³) not beyond 450 m

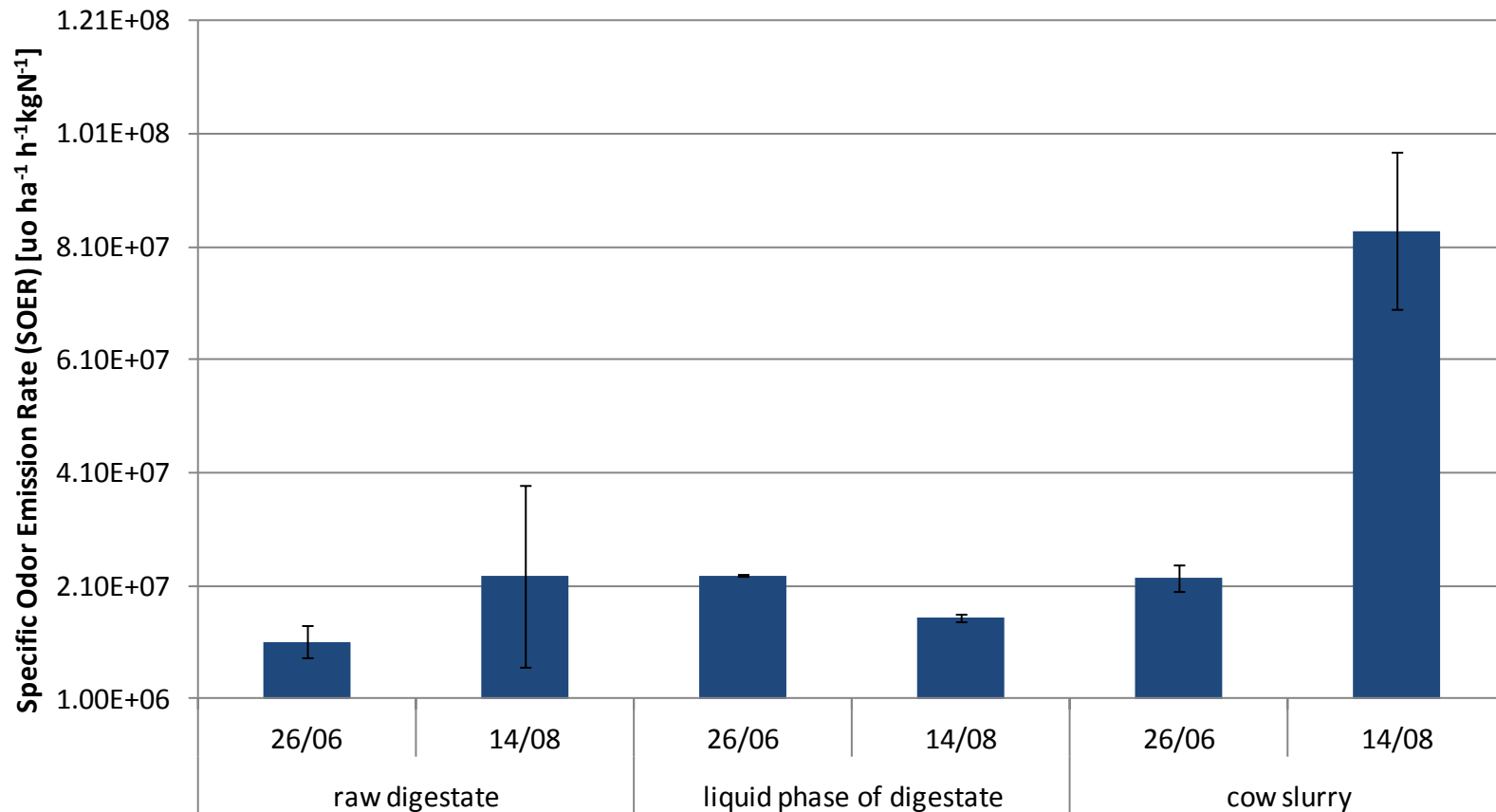
Digestate : weaker odor flow rate, quicker decreasing
 But **different land application system**



Odor flow rate the first hour following land application:

- High variability between application dates → Weather conditions ?
- High variability for the cattle slurry. High value for cattle slurry for one date.

Specific Odor Emission Rate (SOER) per Nitrogen Unit/ha



Conclusions

- Odor annoyance of on-farm biomethanation is similar to a traditional farm of same size. Annoyance zone (P98 for 1 ou/m³) is not beyond 450 m.
- Care must be taken on substrate handling.
- Lower odor emissions of digestate handling than raw slurry
- Odor emission during land application of digested material is lower or similar to raw cattle slurry, as observed in preliminary measurements.

Further work

- Land application → need to increase the data set
- Evaluation of different land application systems (odor concentration, intensity and duration)
- Comparison of the **hedonic tone** and **odor intensity and duration** of digested/treated substrates and undigested/treated substrates of different farms

Thanks for your attention

European Project Interreg IVA

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