

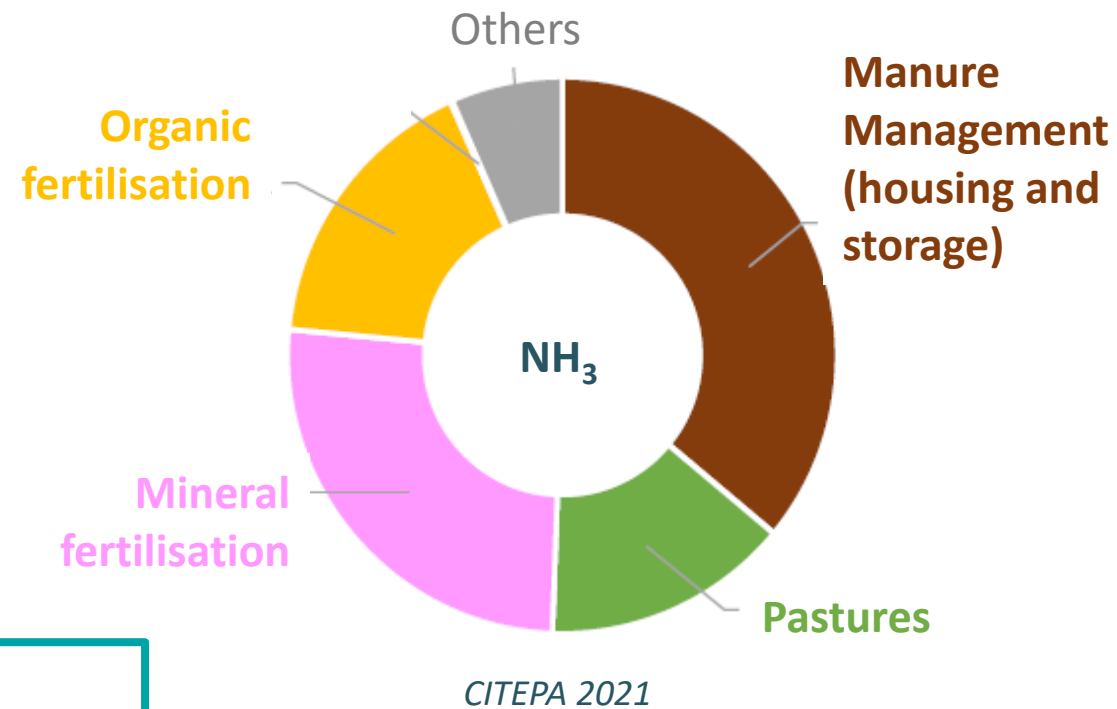
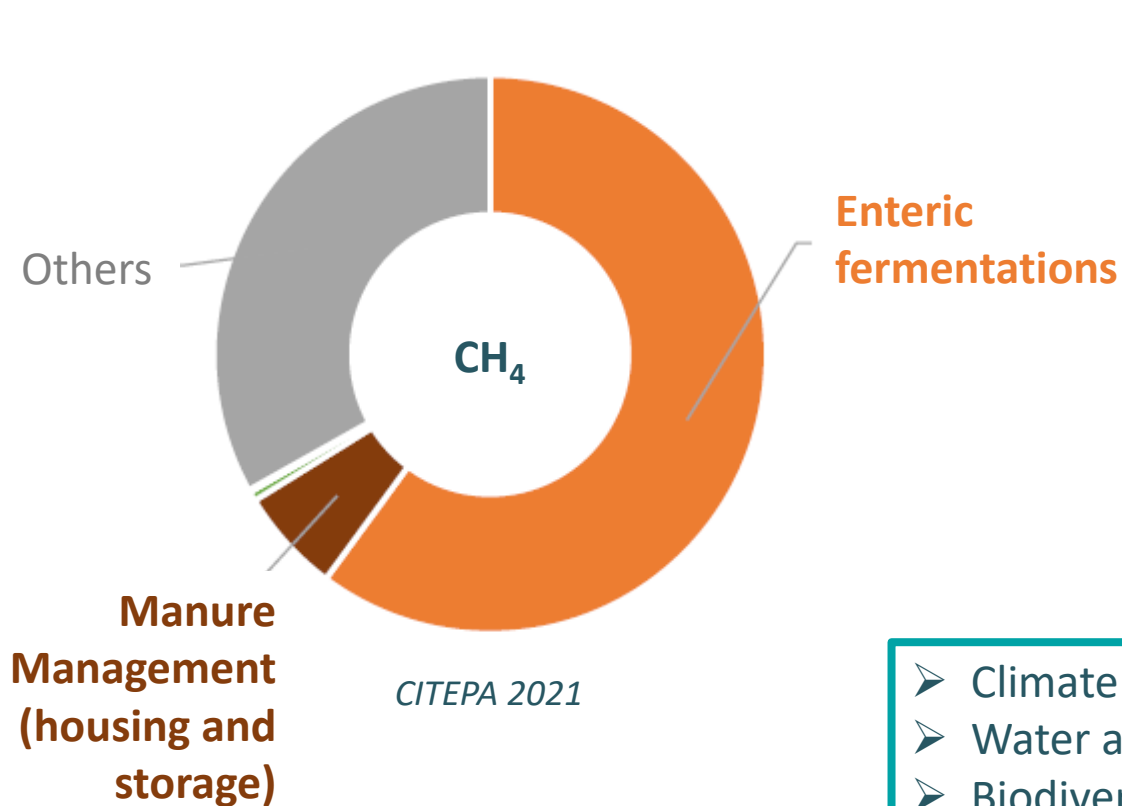


➤ Gas emissions (building, storage, pasture) of dairy systems combining or not grazing and housing

Nadege Edouard, Xavier Vergé, Christophe Flechard, Yannick Fauvel, Adrien Jacotot

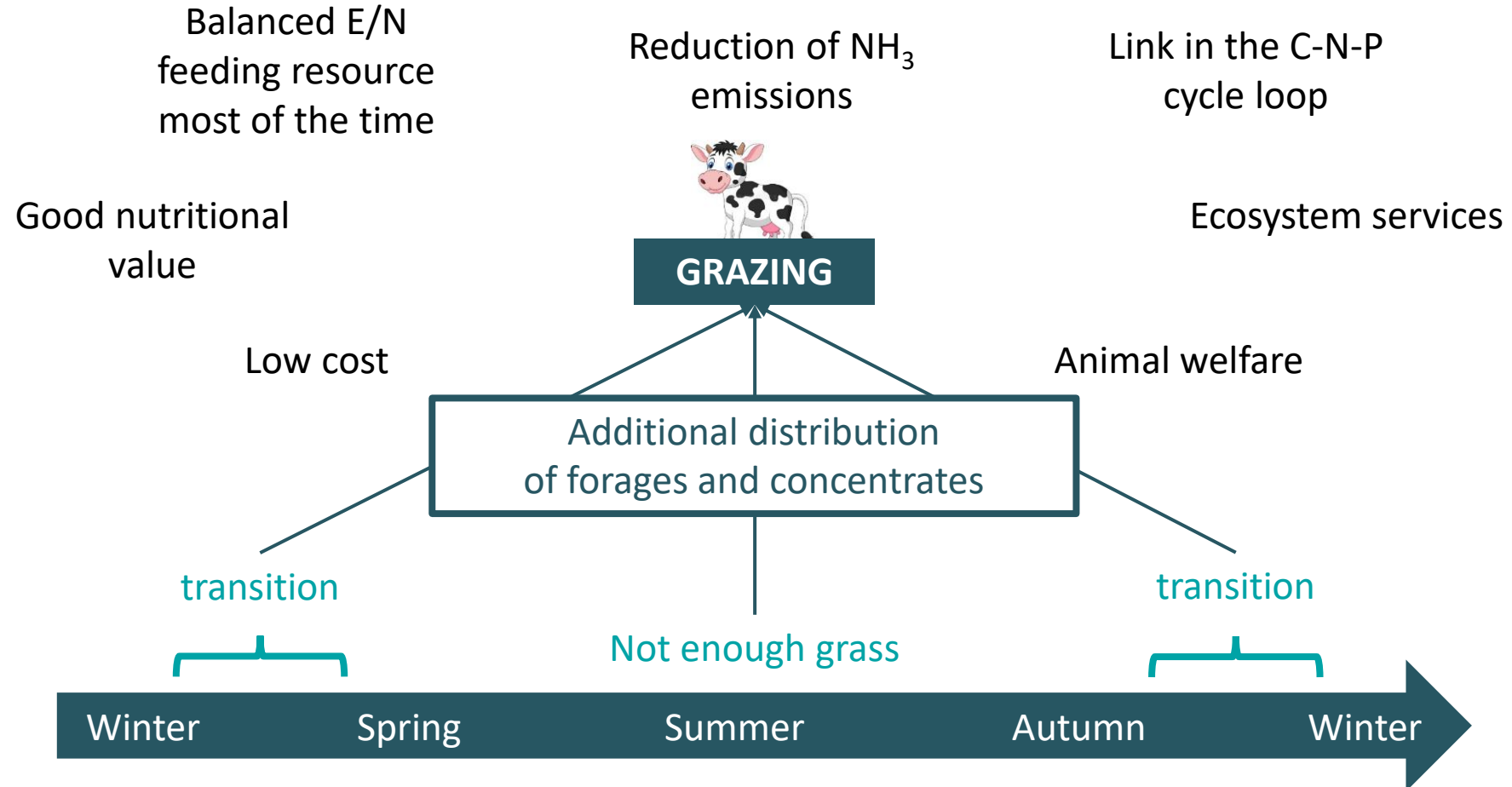
➤ Livestock contributes to environmental impacts

In France, AGRICULTURE accounts for **67% of CH₄** and **94% of NH₃** total emissions
=> mainly due to **livestock**



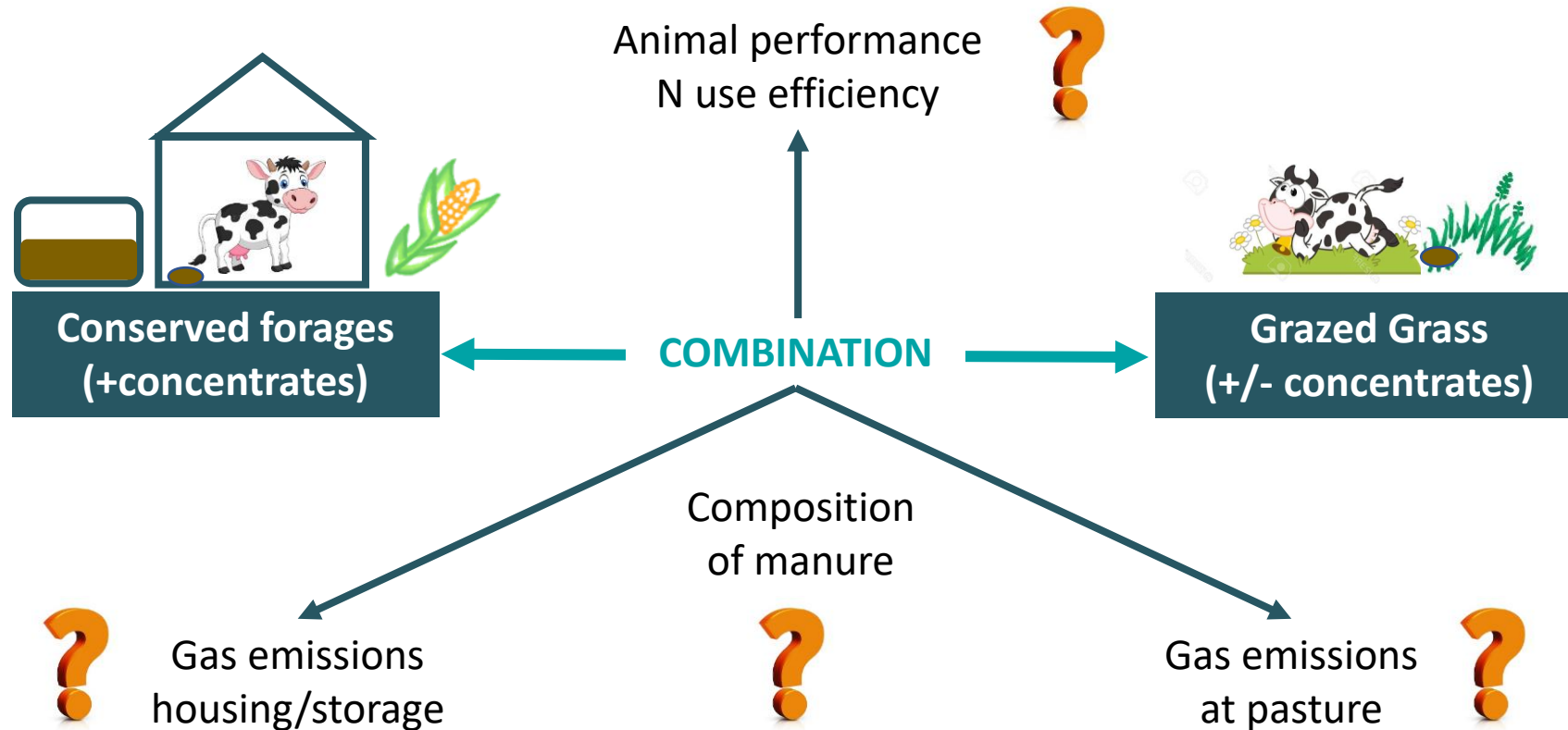
- Climate change
- Water and air pollutions
- Biodiversity losses
- ...

➤ Grazing: a lever for greater sustainability

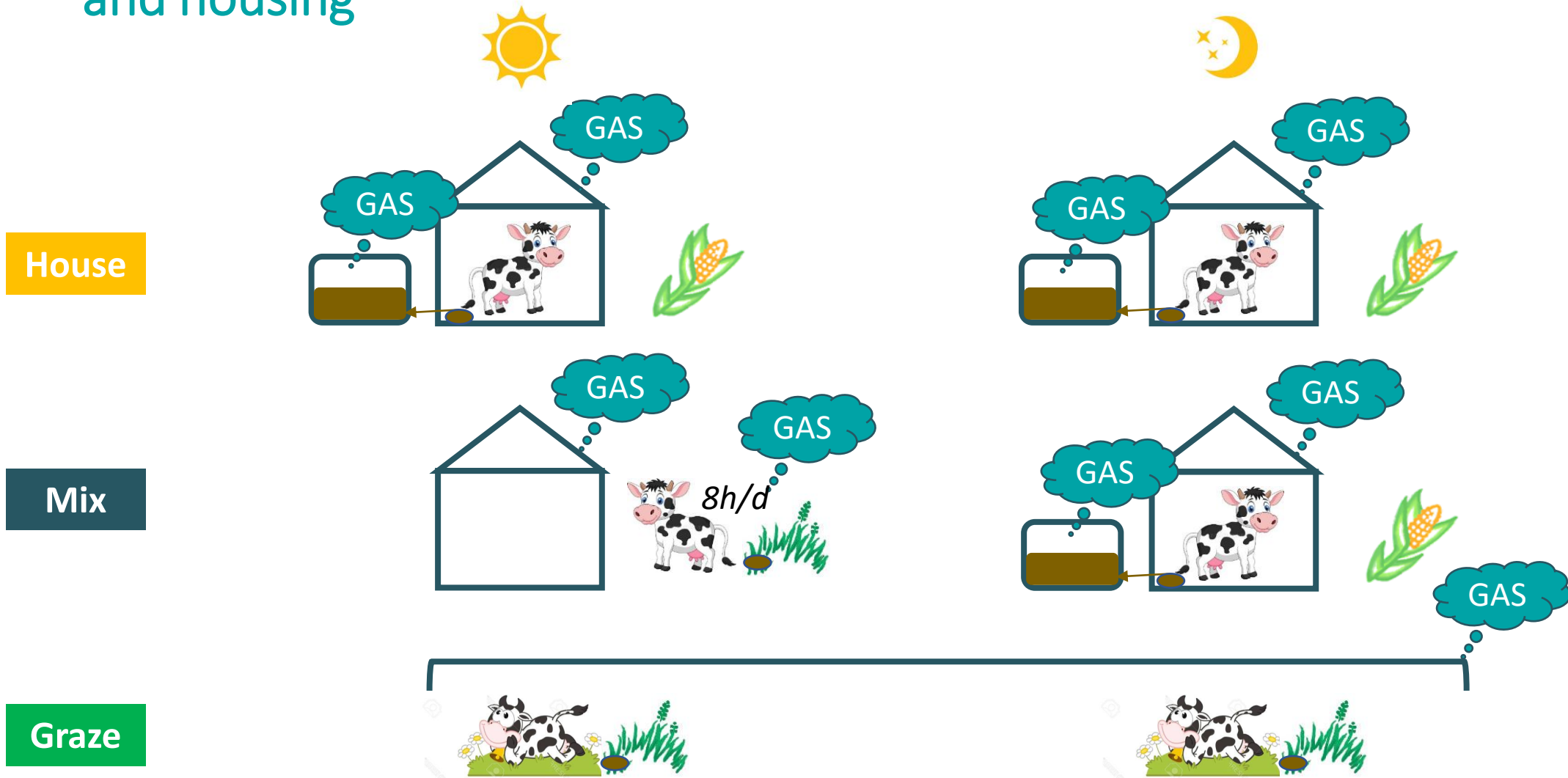


➤ Consequences of combining grazing and forages offered at trough

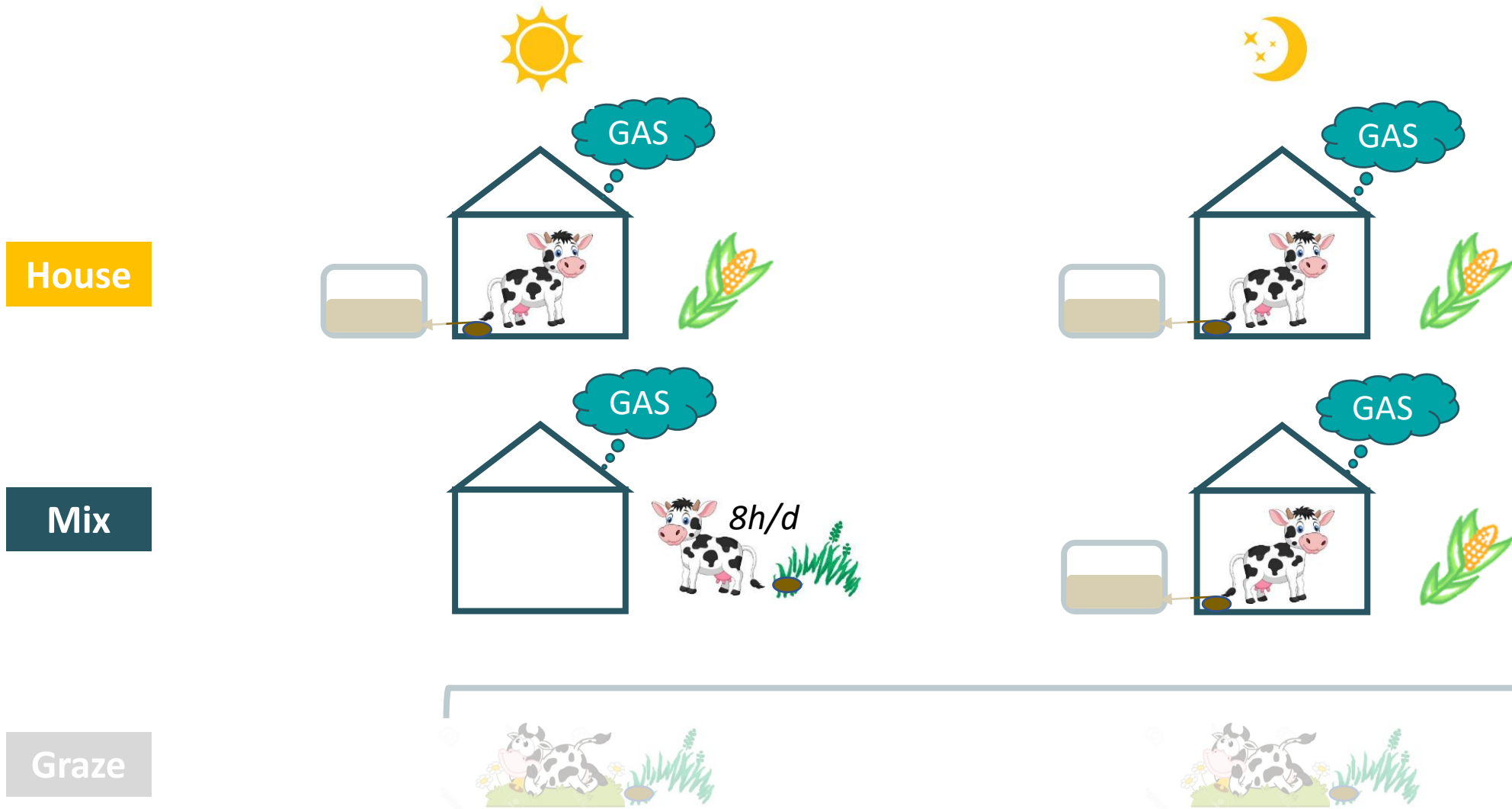
On GHG and NH₃ emissions

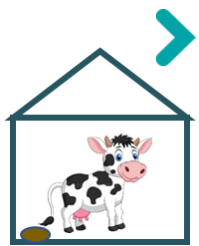


➤ Comparing 3 strategies combining or not grazing and housing



➤ Gas emissions at the BARN level





Gas emissions at the BARN level

Experimental design

autumn **House** **Mix** Graze

1 group = 3 cows
Measures = 5 last d

	Period 1 3 weeks	Period 2 3 weeks	Period 3 3 weeks
Group 1	House	Mix	House
Group 2	Mix	House	Mix



House :
Total Mix Ration ad lib

Mix :
8kgMS TMR in the evening



TMR:
75% maize silage
15% soya meal
10% cereals

Grazing:
Temporary
pasture
0,5 à 1ha



24h/day

16h/day



8h/day

between milkings

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Gas emissions at the BARN level

Dynamic ventilation rooms – free stall barn

autumn

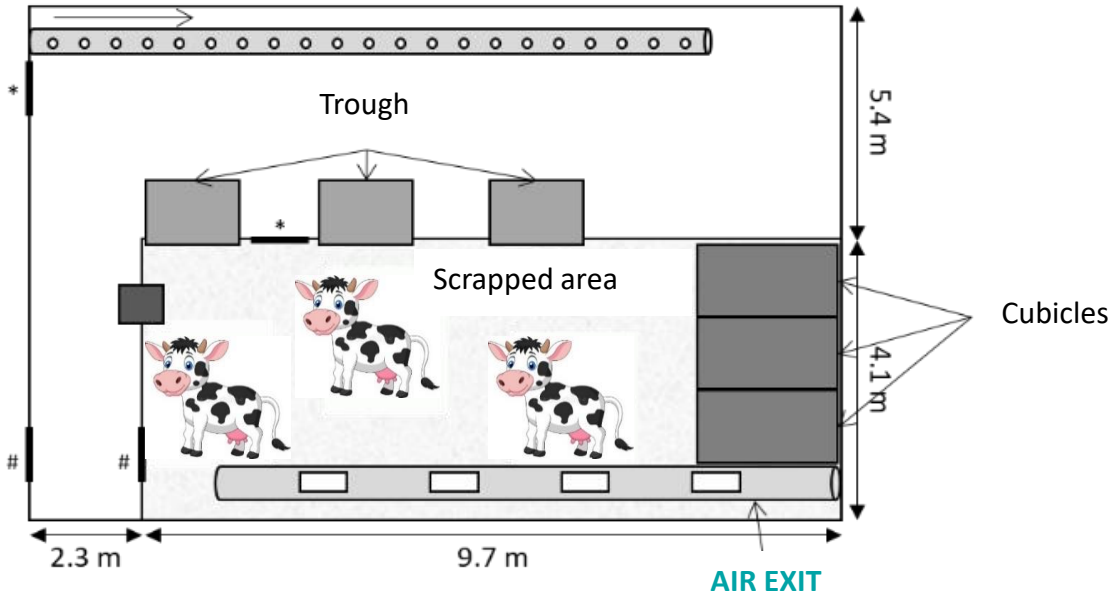
House

Mix

Graze

AIR ENTRY

Gas concentrations

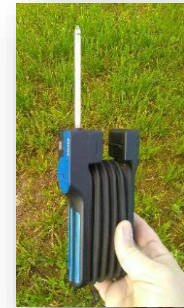


Analyser INNOVA

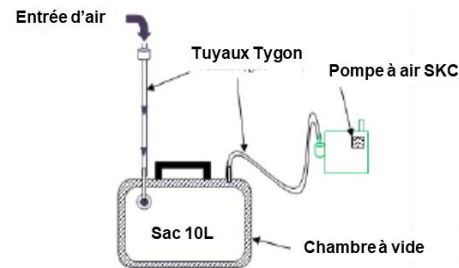
Colorimetric tubes

CH₄ - N₂O - CO₂

NH₃

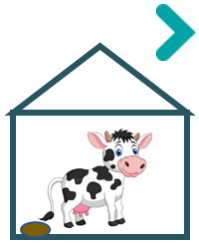


Spot gas sampling in **air entry** and **air exit** at 7:00 before feeding and 18:00 after feeding



- + DM Intake
- Milk Yield
- Milk composition
- Manure composition
- ...

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Gas emissions at the BARN level

autumn

House

Mix

Graze

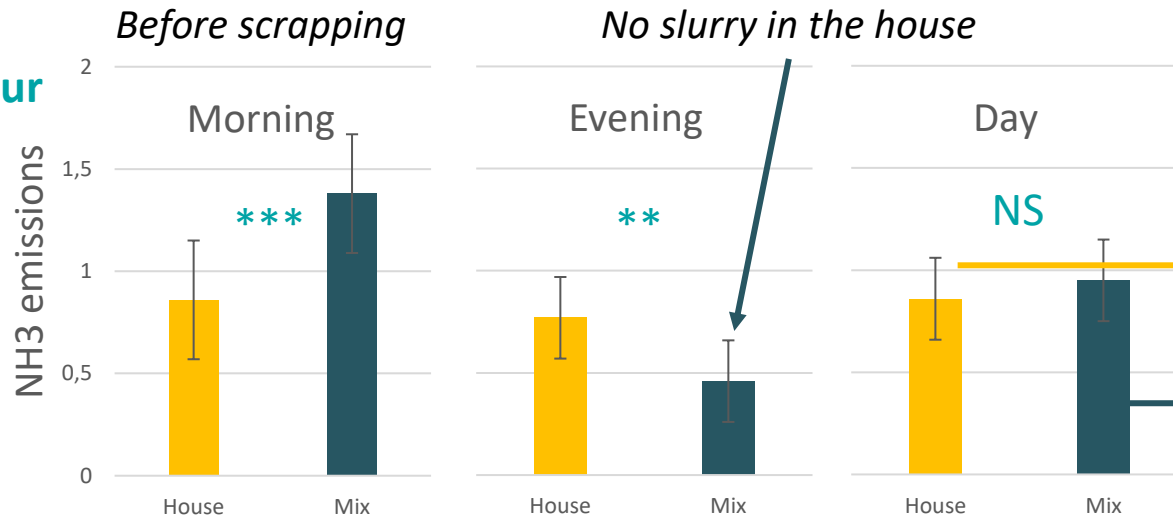
NH₃ emissions

		House		Mix	P-value	RMSE
CP intake	kg/cow/d	3.6	<	4.9	***	0.2
Slurry N content	g/kg	37	<	46	*	0.3

Diet CP content:
14%
22%

+1.3 kgCP for Mix despite lower DMI

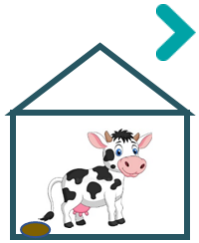
g/cow/hour



At the BARN and DAY level

x 24h/day => 21 gNH₃/cow/day

x 16h/day => 15 gNH₃/cow/day



Gas emissions at the BARN level

NH₃ emissions

autumn

House

Mix

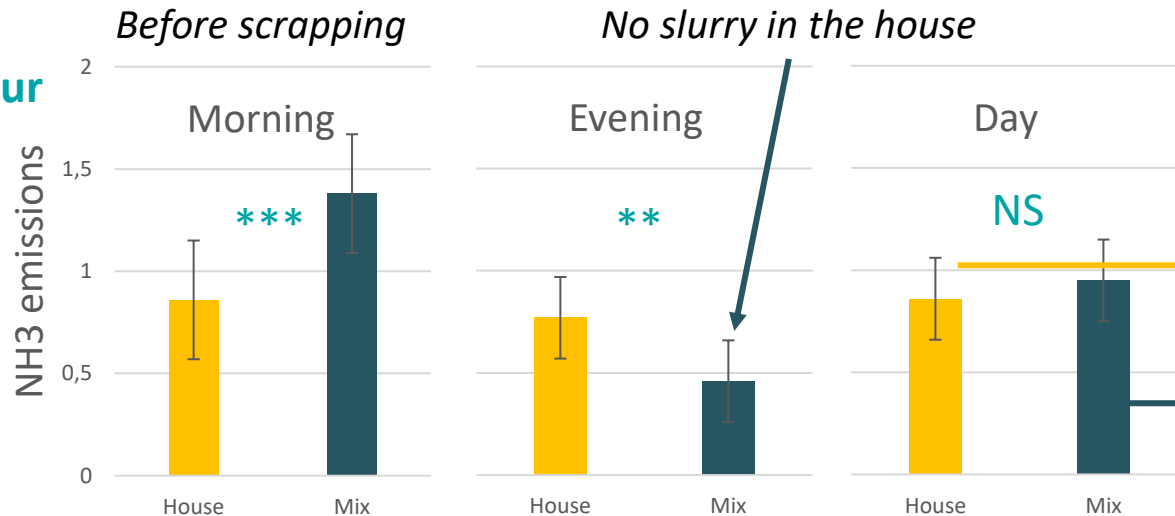
Graze

Ammonia emissions in g/cow/hour are higher for cows eating grass with high CP content when there is N-rich slurry in the house (morning) but daily emissions are lower due to lower amount of slurry in the house

Diet CP content:
14%
22%

+1.3 kgCP for Mix

g/cow/hour



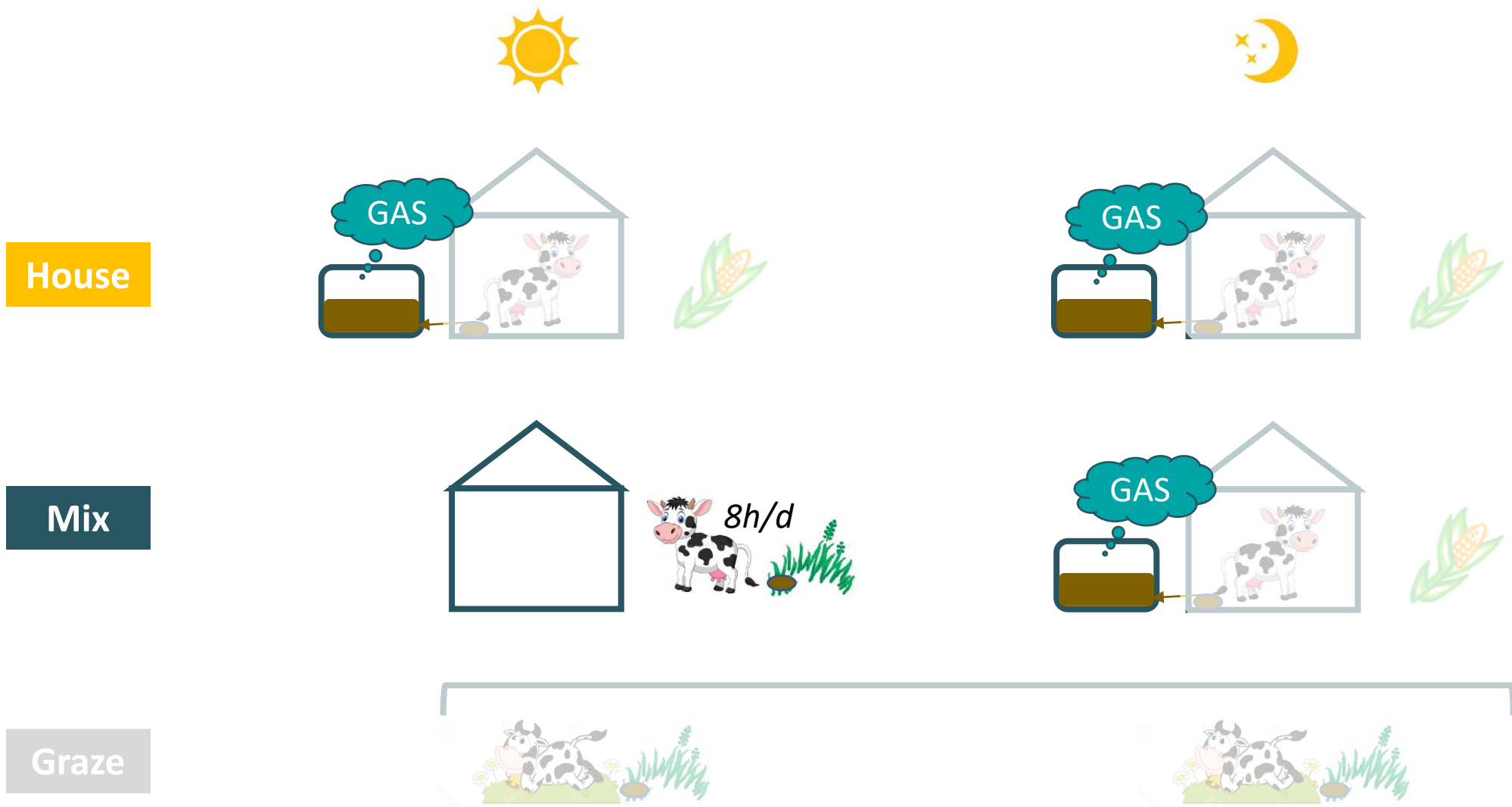
At the BARN and DAY level

x 24h/day => 21 gNH₃/cow/day

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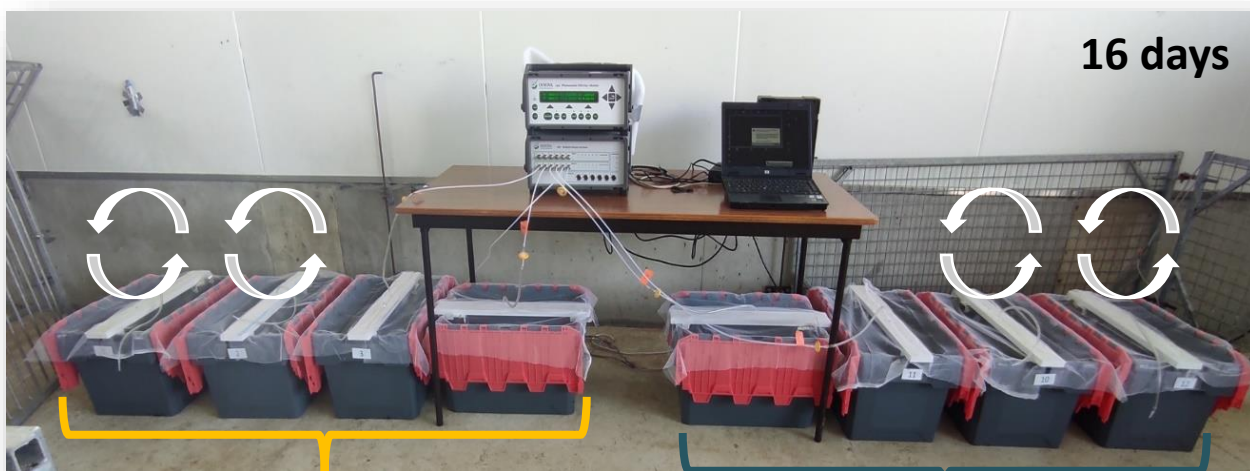
➤ Gas emissions at the STORAGE level



➤ Gas emissions at the STORAGE level



Passive flux chambers



House

Mix

- 100 kg slurry / treatment collected in 2 consecutive days during week 3 of the BARN phase
- Homogenized and separated in 4 containers / treatment
- Slurry regularly mixed (2 containers /treatment) or not (2 containers /treatment)

autumn

House

Mix

Graze

Spot gas sampling:
Gas concentrations

Colorimetric tubes

NH_3 - CO_2



Chromatography

CH_4 - N_2O - CO_2



Cameras



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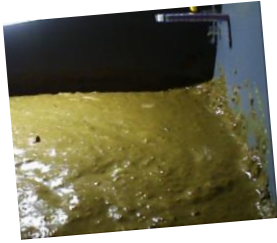
Gas emissions of dairy systems combining or not grazing and housing
28th August 2023 / EAAP Annual Meeting / Edouard N et al.

Gas emissions at the STORAGE level



Manure characteristics - composition

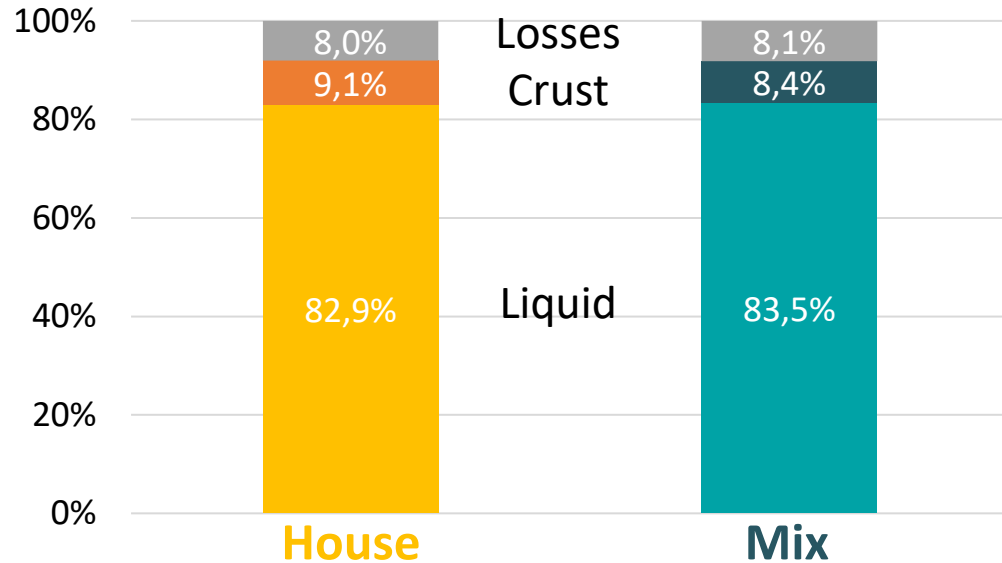
Day 1



Day 16



Final manure matter distribution
(without slurry mixing)



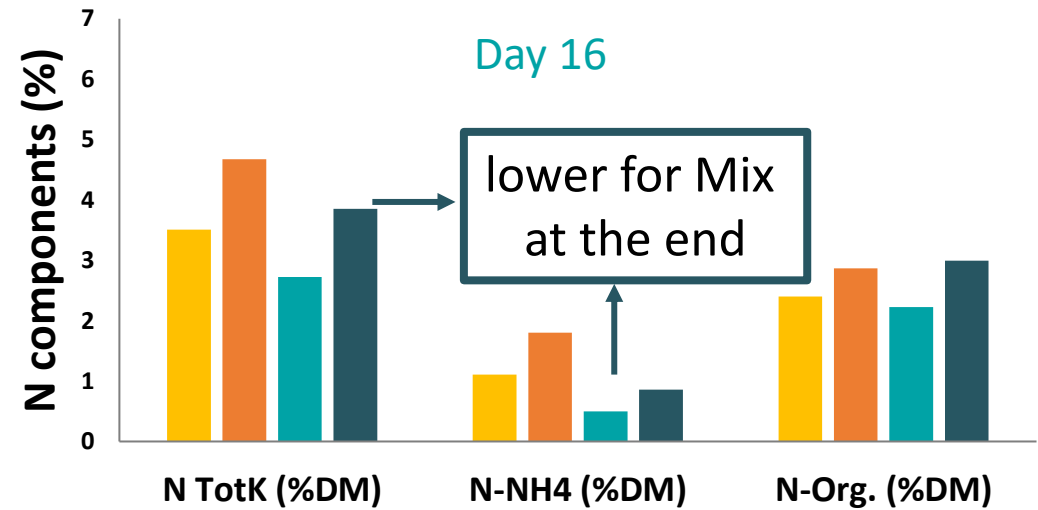
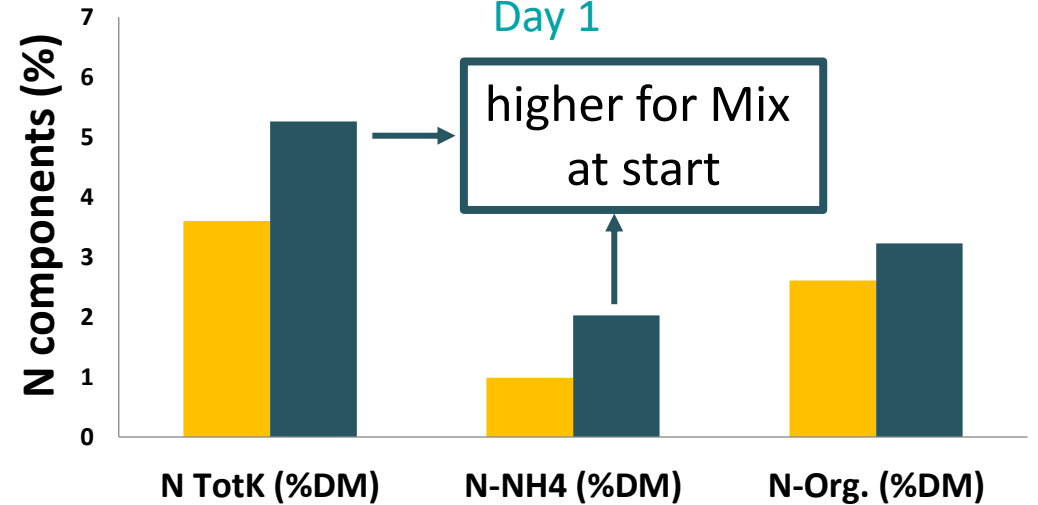
=> Similar between feeding treatments

autumn

House

Mix

Graze



Gas emissions at the STORAGE level

autumn

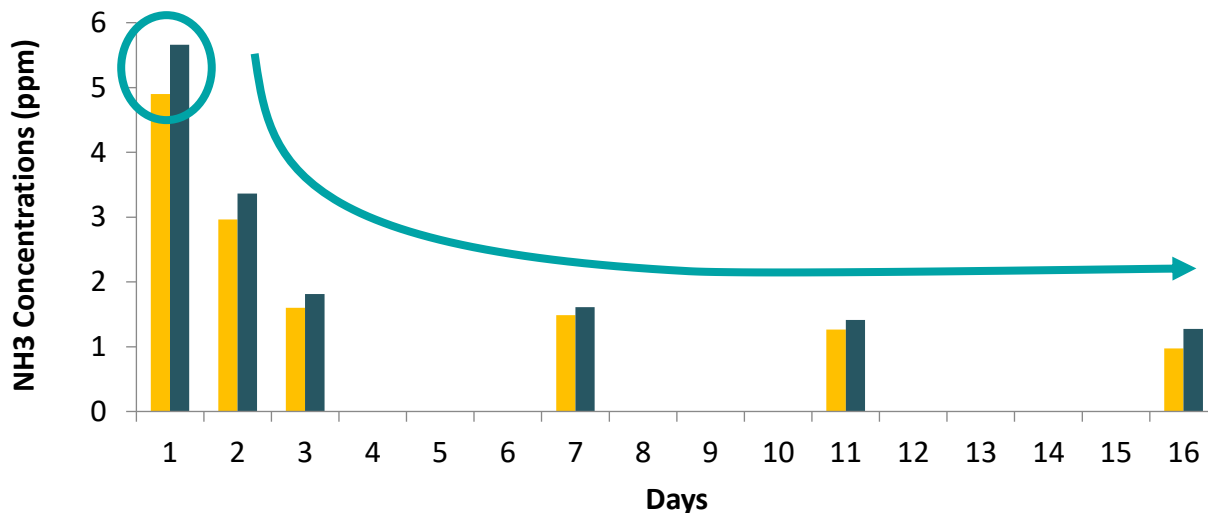
House

Mix

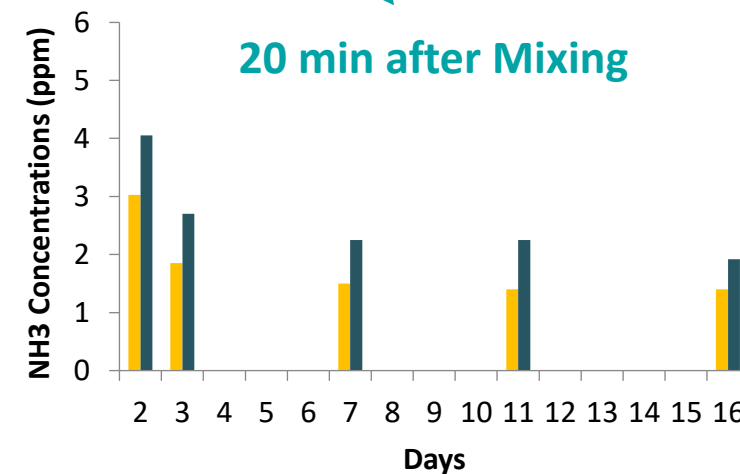
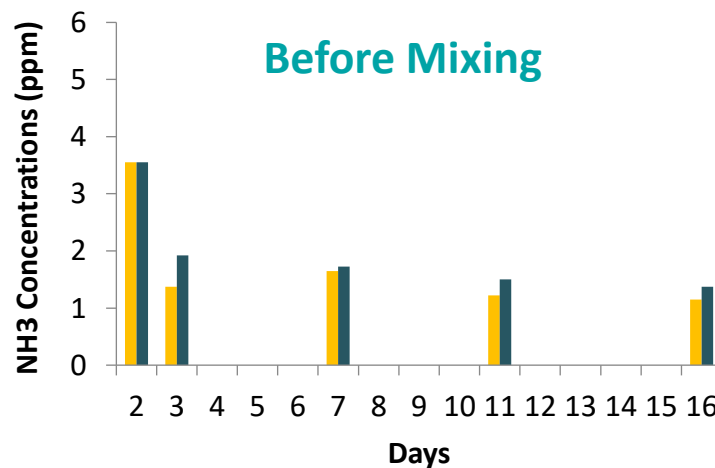
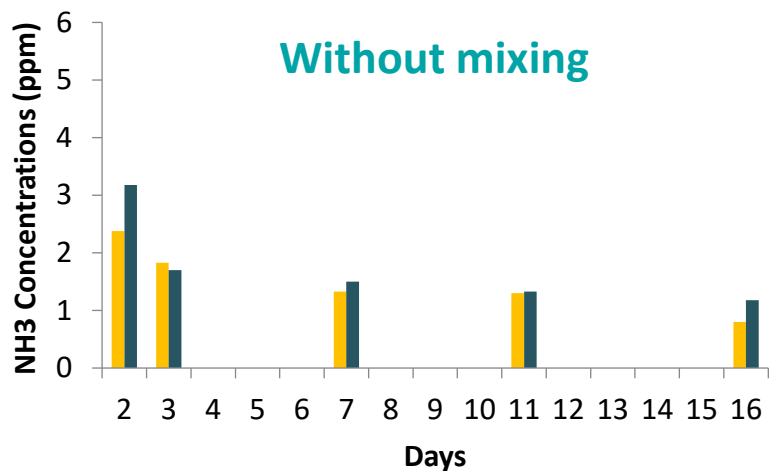
Graze



NH₃ volatilisation

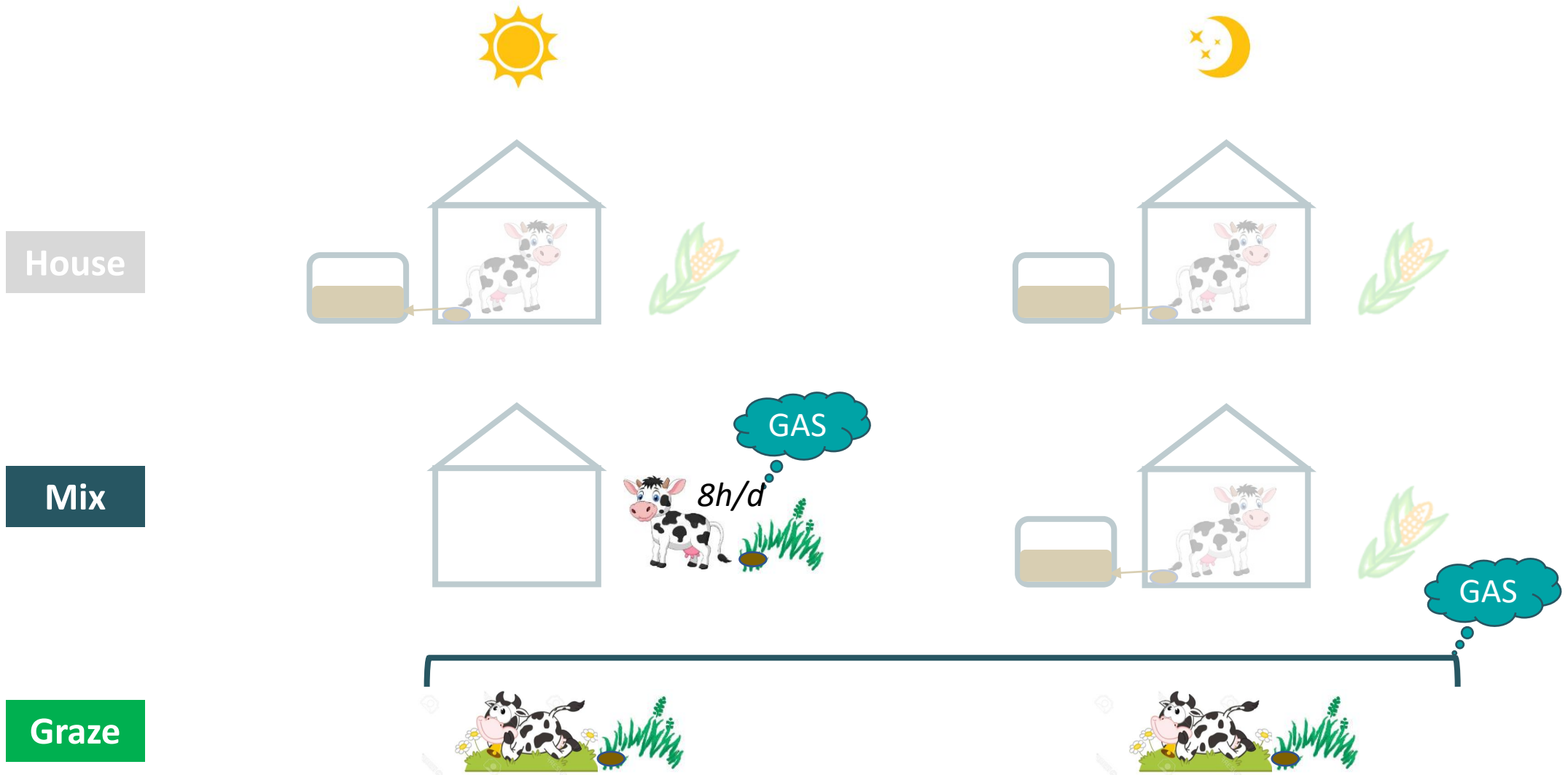


- [NH₃] decreases quite rapidly
- Slightly higher [NH₃] for **Mix** vs **House** on day 1, almost similar thereafter
- Difference more visible just after mixing the manure



MIX: higher NH₃-N in slurry => higher NH₃ volatilisation

➤ Gas emissions at the PASTURE level





Gas emissions at the PASTURE level

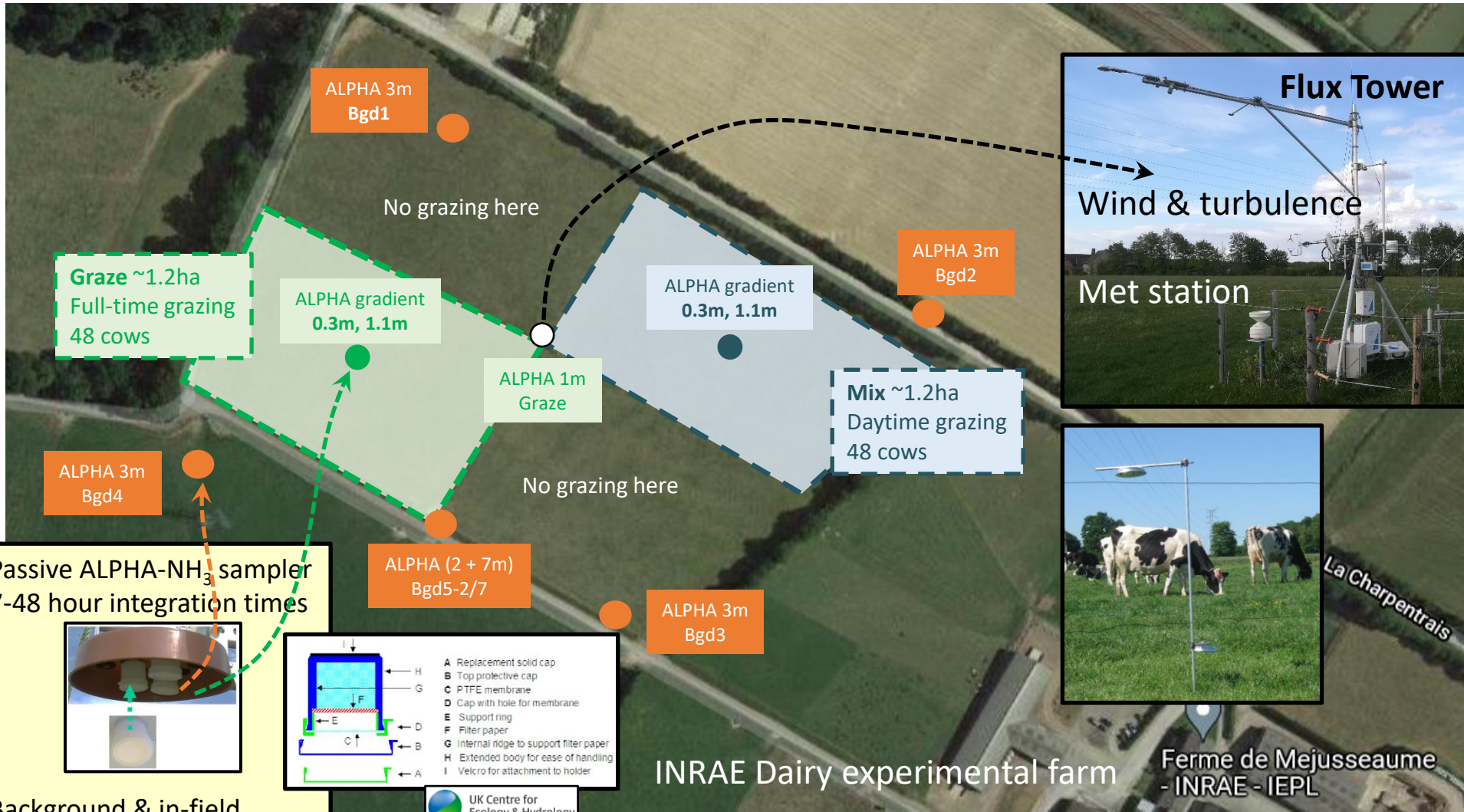
spring

House

Mix

Graze

Inverse dispersion method to compare field-scale NH₃ emissions with ALPHA passive samplers



- **Horizontal and vertical NH₃ concentration gradients** above pasture and in surrounding fields
- **Atmospheric turbulence and wind** using ultrasonic anemometer
- **Short-range** (Gaussian, Loubet et al., 2010; FIDES model) **atmospheric dispersion modelling** to infer emission fluxes from concentrations and turbulence



Gas emissions at the PASTURE level

spring

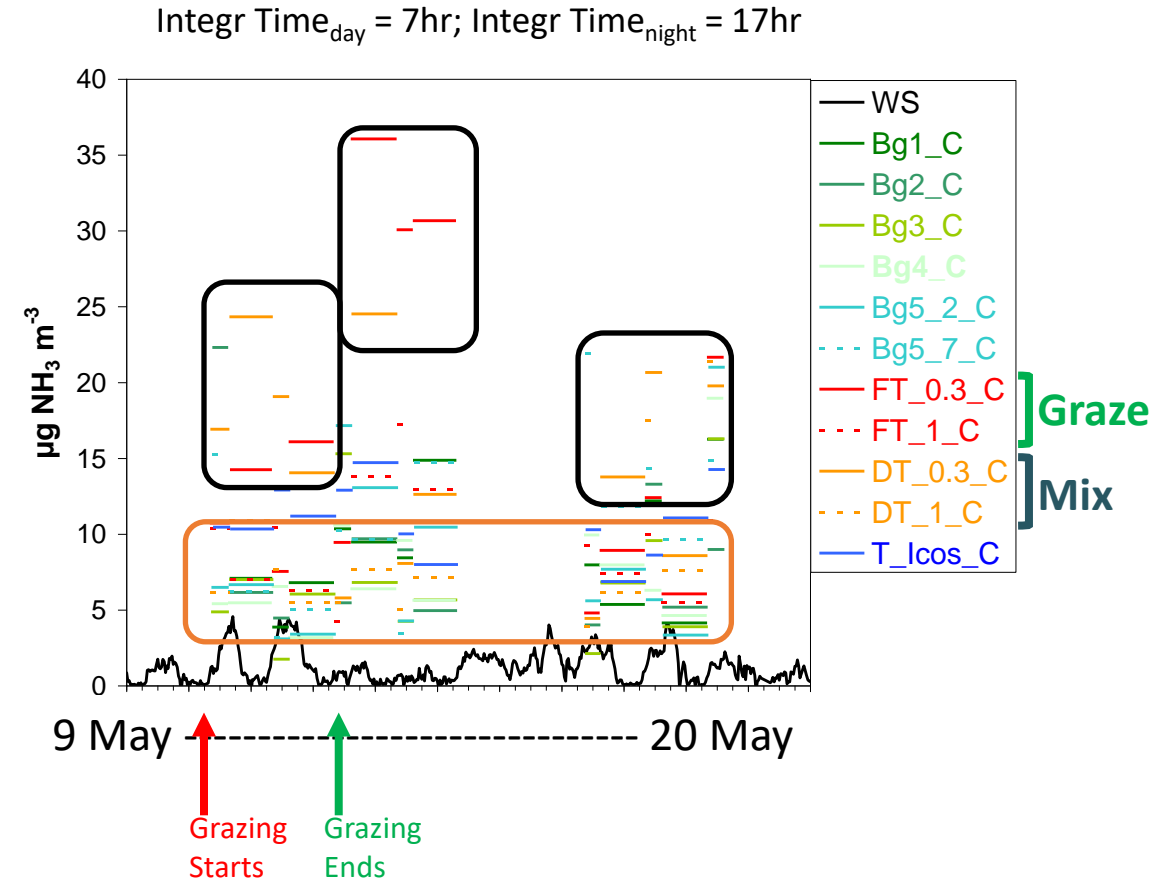
House

Mix

Graze

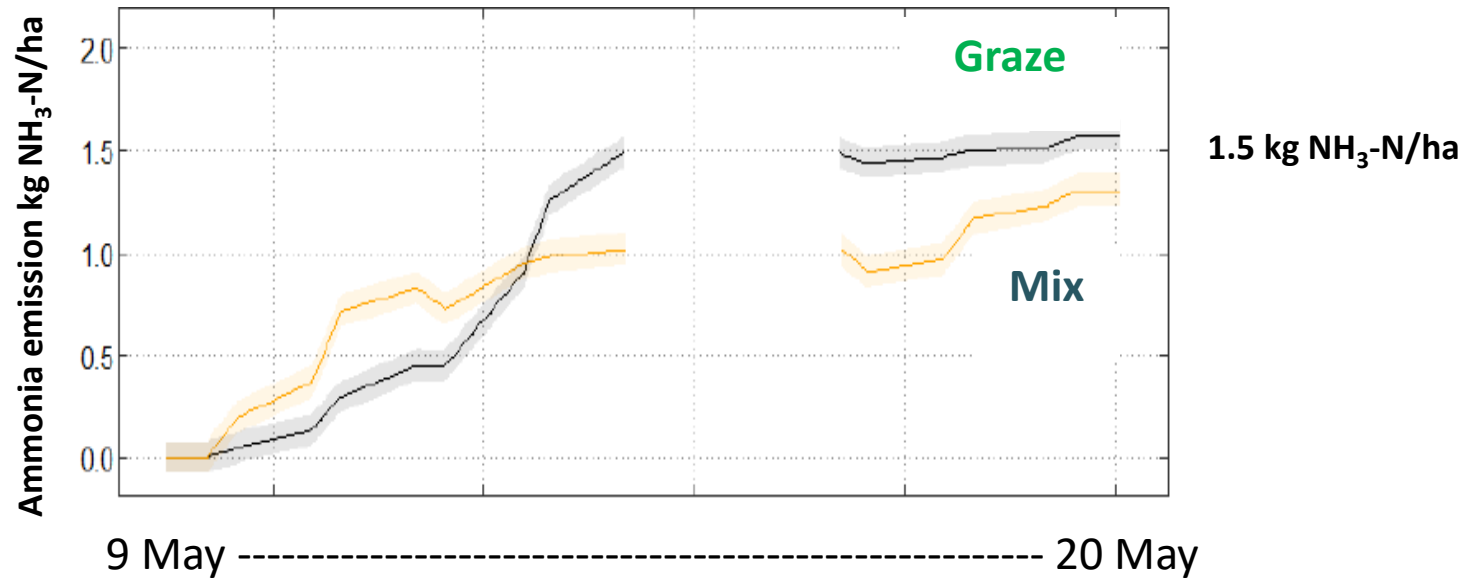
Inverse dispersion method to compare field-scale NH_3 emissions with ALPHA passive samplers

- NH_3 concentrations clearly larger within **Graze** and **Mix** paddocks, compared with **surrounding/background** (non-grazed) fields
- Emission gradient peaks for 2 days after end of grazing phase, then almost vanishes after ~one week



➤ Gas emissions at the PASTURE level

Inverse dispersion method to compare field-scale NH_3 emissions with ALPHA passive samplers



- Cumulative emissions in **Graze** apparently tend to be only marginally larger than in **Mix** grazing
- But differences are **not significant** due to large uncertainties in dispersion modelling



➤ Gas emissions at the PASTURE level

spring

House

Mix

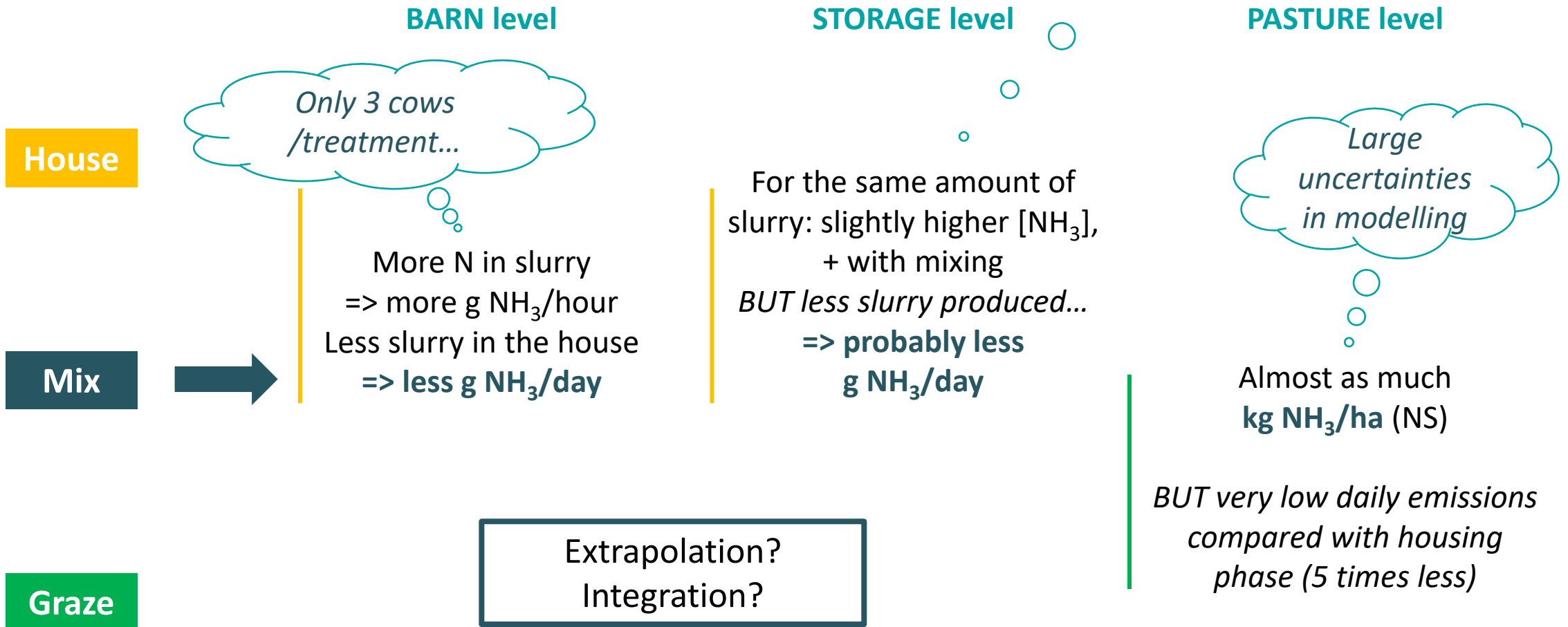
Graze

Tentative annual upscaling and grazing-induced emission factors

- With 48 cows/ha, 1.5 kg N cumulative emission over 10 days corresponds to
=> a **daily emission rate of ~ 3.8 g NH₃/cow/d**
- **Similar magnitude with previous NH₃ emission measurements** on the same field using high resolution mini-DOAS NH₃ concentrations and inverse dispersion modelling:
=> *Bell et al 2017 (Atmos. Meas. Tech)* = ~ **5.7-6.2 g NH₃/cow/d**
- Assuming 8 months per year of grazing (March-October), this is equivalent to
=> an **annual grazing emission rate of 1 kg NH₃/cow/year**
- The low resolution/low cost diffusion ALPHA sampler & inverse dispersion method provided **realistic estimates**, but is likely **not sensitive enough** to detect differences between **Graze/Mix** grazing treatments

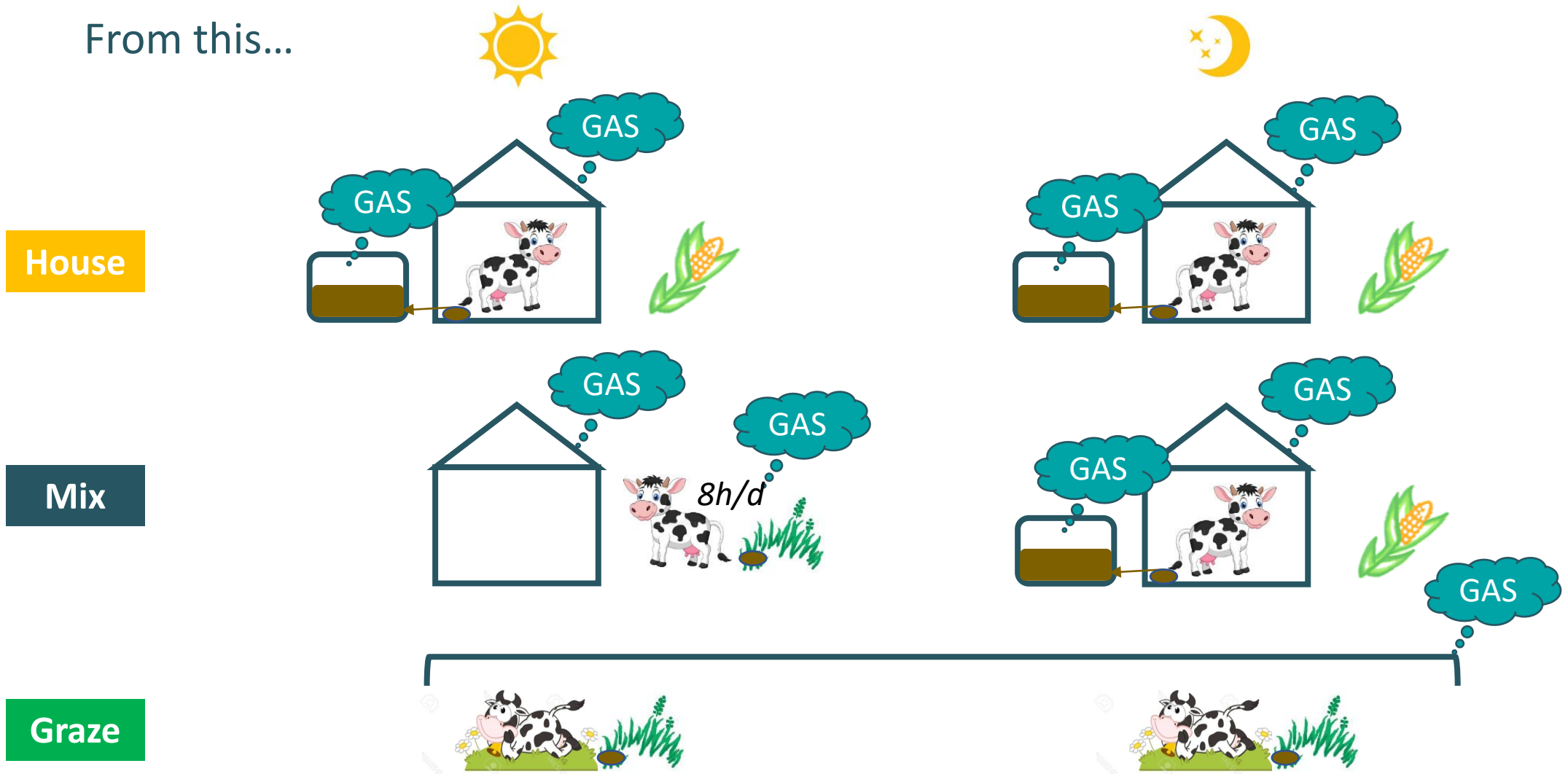
➤ Some conclusions and limits

NH₃ emissions



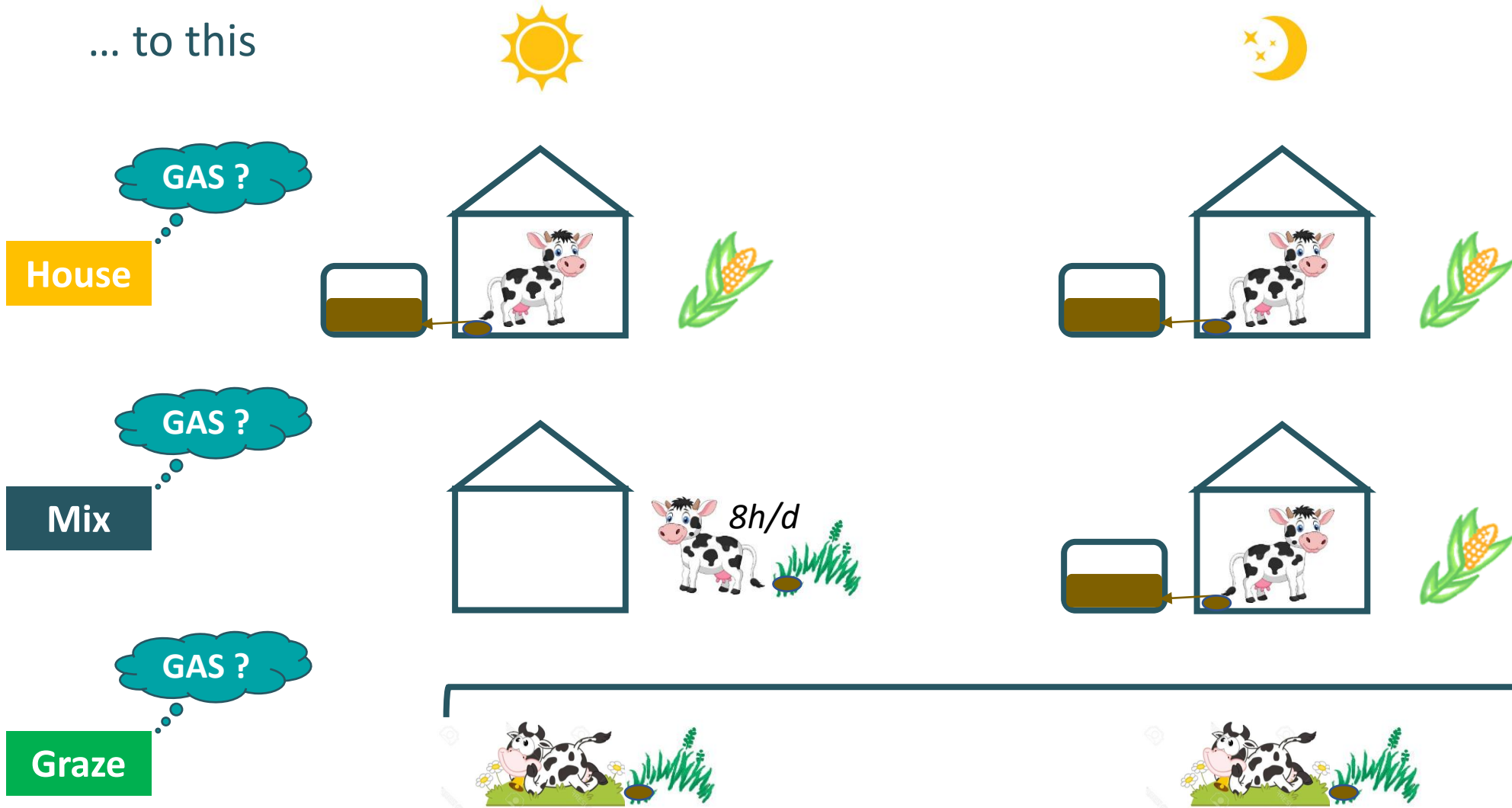
➤ Need to integrate the whole manure management chain and all gases

From this...



➤ Need to integrate the whole manure management chain and all gases

... to this



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Gas emissions of dairy systems combining or not grazing and housing
28th August 2023 / EAAP Annual Meeting / Edouard N et al.



THANK YOU FOR YOUR ATTENTION!

Acknowledgements:

ERA-NETs SusAn, FACCE ERA-GAS & ICT AGRI 2018 Joint Call

ANR: Agence Nationale de la recherche (France)

ADEME: Agence de la Transition Ecologique (France)

For more information: www.CCCfarming.eu



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