GrassToGas:
Strategies to mitigate greenhouse gas emissions from pasture-based sheep

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SRUC

International Project, 10 partners from 7 countries, 2019-2023

GrassToGas

Norway

Norwegian University of Life Sciences

NSG Norsk sau og geit

UK

SRUC

TEXEL SHEEP SOCIETY

NZ

agresearch
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Ireland

eagasc
Agriculture and Food Development Authority

Sheep Ireland
www.sheep.ie

France

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

INRAE

Turkey

REPUBLIC OF TURKEY MINISTRY OF AGRICULTURE AND FORESTRY
INTERNATIONAL CENTER FOR LIVESTOCK RESEARCH AND TRAINING

Uruguay

INIA
Instituto Nacional de Investigación Agropecuaria
URUGUAY

Smarter

SMAll RuminanTs breeding for Efficiency and Resilience

WP1. Novel traits to improve resource use efficiency

Identify novel phenotypes related to resource use efficiency:

- feed efficiency
- body tissue mobilisation
- methane emissions

www.smarterproject.eu

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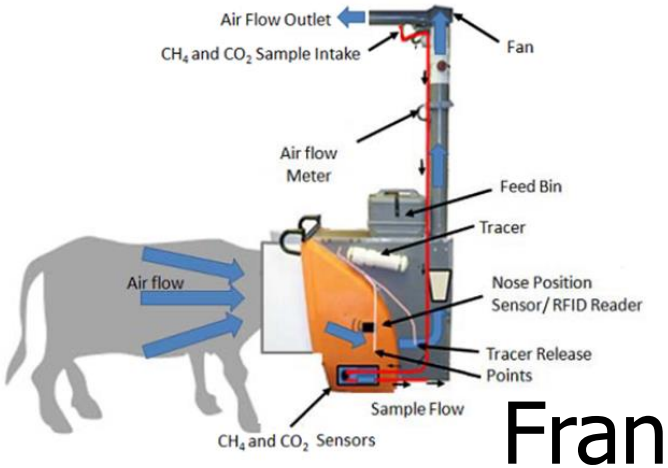
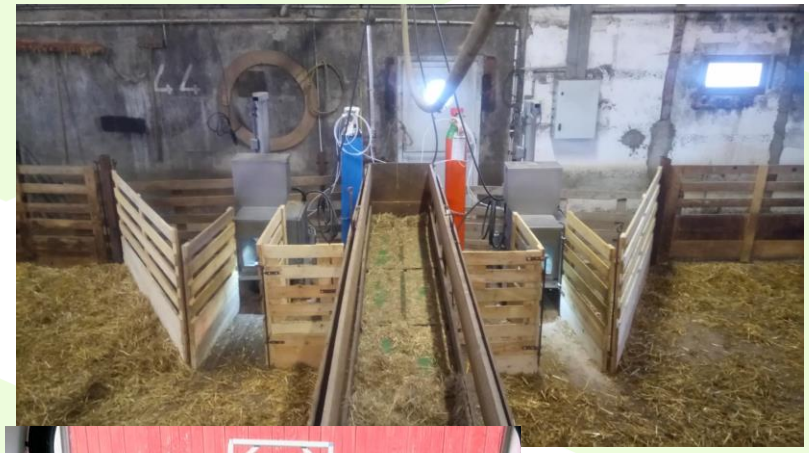
Previously?



France



Norway

UK

Ireland

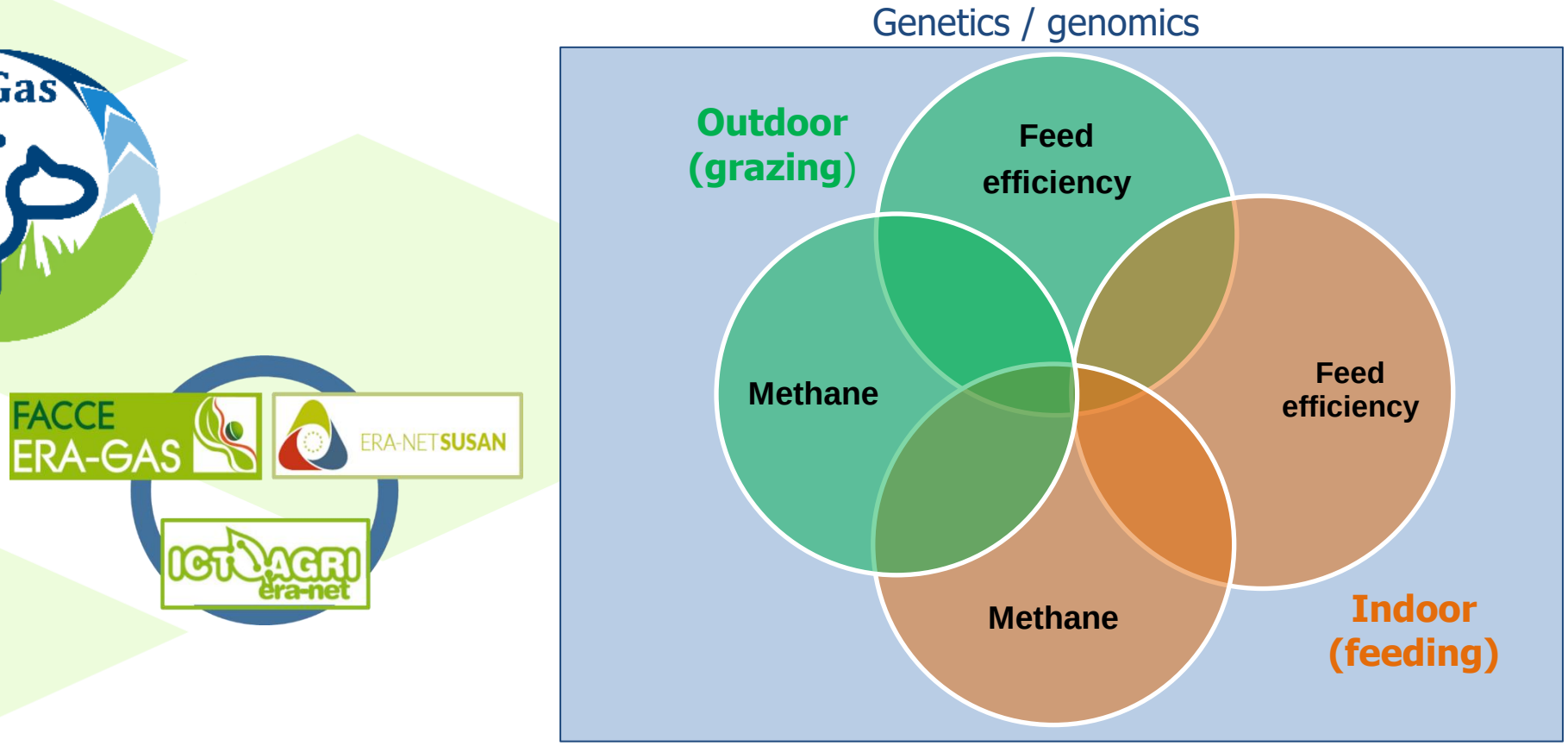
Uruguay

NZ

++ others...

Grass to Gas project (2019-2023)

Strategies to mitigate GHG emissions from pasture-based sheep systems



GrassToGas solutions

- Develop breeding and feeding approaches to mitigate GHG emissions from pasture-based sheep systems
- Deliver applied solutions to methane emissions by combining precision animal monitoring and new genetic/genomic technologies
- Quantify economic and environmental benefits of more feed-efficient and lower GHG-emitting sheep

Five Aims

1. Validate predictors of feed intake, feed efficiency and methane emissions

Five Aims

2. Compare indoor vs outdoor feed efficiency and methane emissions

Five Aims

3. Investigate the opportunity to use genetics and genomics to reduce methane (CH_4) emissions
   - genetic control – feed efficiency and methane?
   - impact of genetic selection on CH_4?
   - genomic diversity of rumen microbial communities?
   - links between phenotypes and host genome?

Five Aims

4. Quantify economic and environmental benefits of more feed-efficient and lower GHG-emitting sheep

   Identify / quantify potential trade-offs via modelling approaches

   Ensure relevance from farm to international impact scale

Five Aims

5. Deliver applied solutions – Impact delivery

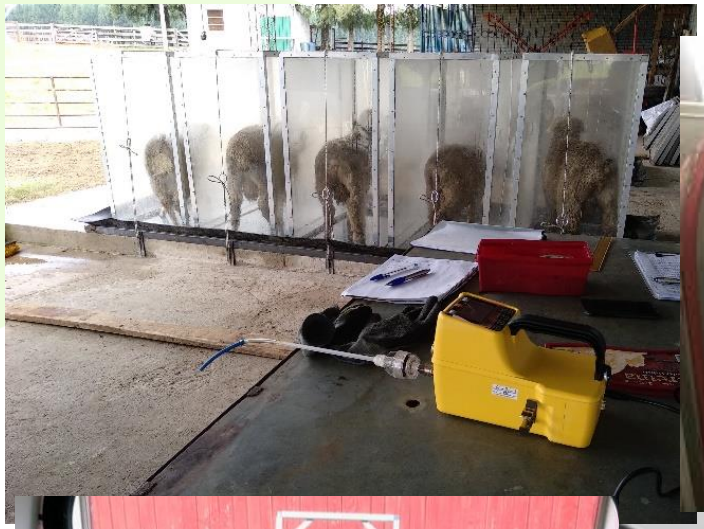
Communication of outcomes to industry and policy - recommendations

Progress – where have we got to?

- Focus on measuring methane emissions, feed efficiency, potential predictors, animal performance (COVID delays)

Direct measurement of methane emissions

Norway, Ireland, France, Uruguay, NZ (& soon UK!)







Computation of methane emissions, oxygen consumption, CO_2 emission /kg LWT /hr

Number of animals - Collected data (projected total number)

TRAIT	INRAE	SRUC	INIA	Teagasc & Sheep-IE	NMBU	AGRES*	ICLRT
Feed intake (concentrate)	451						
Feed intake (forage)	408	239	1,770	228 (400)	80	X	
Feed intake (water)	402						
GHG emissions	~50 (350)		1,707	1,180 (2,500)	80	X	
Body weights – ADG	451	481	1,770	540 (1,500)	80	X	X
Body composition: ultrasound	451	481	1,770	60 (800)		X	
Body composition: CT-scanning and MRI	48	347				X	
Body composition: MRI	24						
Carcass traits		360	100	200 (800)		X	
Body condition scores	~50		1,770	850 (1,100)	40	X	
Rumen volume (CT scan)	48	347				X	
Blood metabolites	277			60 (200)			
Genetic markers	349		1,410		39		
NIRS on faeces	277						
Ruminal datasets	277		100 (300)	60 (200)	48	X	
RumiWatchSystem				60			
Feed quality	X	X	X	X	X	X	X

*AgResearch – no GrassToGas experimental work; data available from other trials

Validating predictors of FI & methane

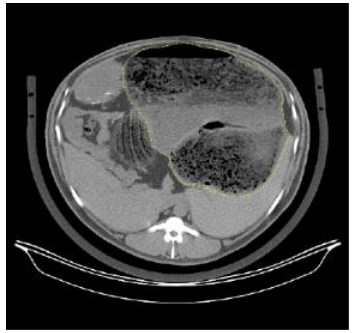
- Summer **2021 and 2022**
- Texel x Mule finishing lambs (n = 481)
  - sired by performance-recorded Texel sires (EBV range)
  - recorded through feed intake recording equipment (n = 239)
  - forage-based diet (grass nuts)
- CT and ultrasound scanned at start & end
  - body composition for efficiency calculations
  - CT rumen volume as methane predictor
- Growth and feed quality measured
- Prediction equations for feed efficiency

Indoor vs outdoor FE & methane

- Summer **2021 and 2022**
- Texel x Mule finishing lambs
  - siblings of lambs in indoor FI equipment
  - grazed on pasture (n = 242)
- Record:
  - grazing offtake
  - growth
  - body composition (US all & CT sub-sample)
  - CT rumen volume (sub-sample)
- Related lambs compared indoor/outdoor



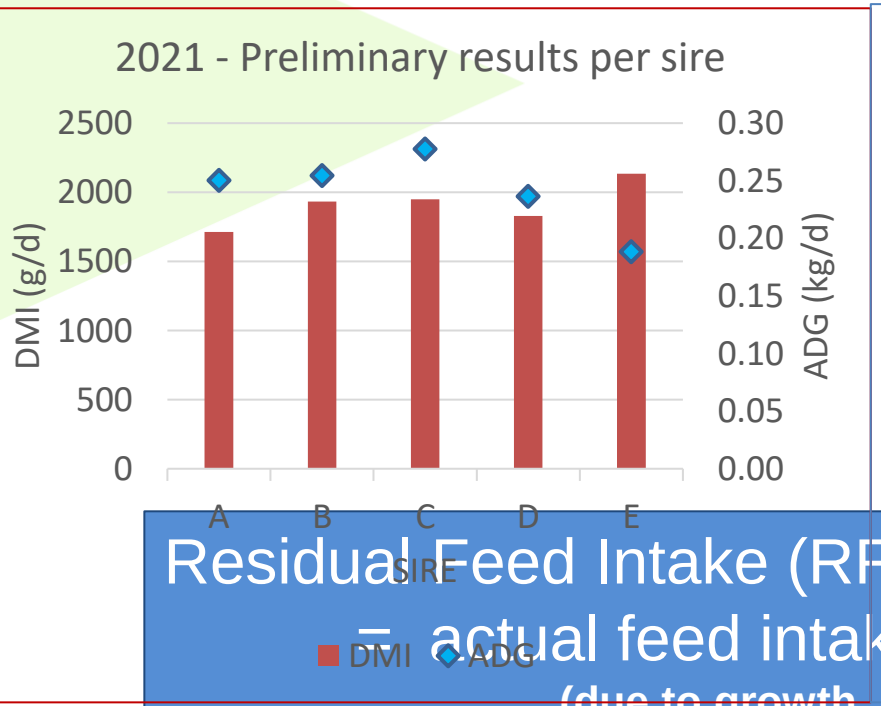


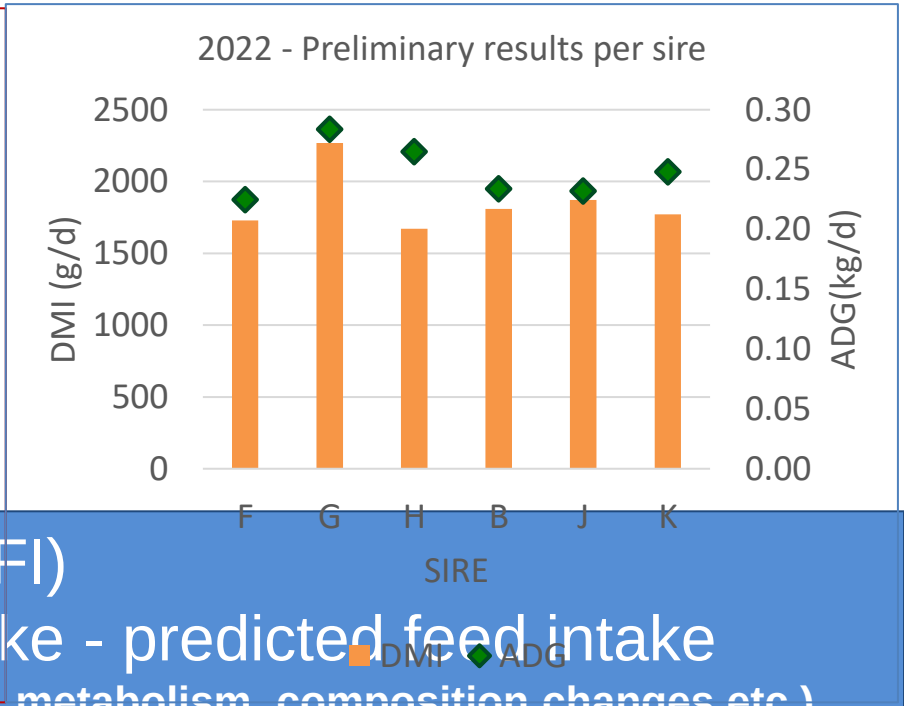


Key progress / findings so far (across partners)

Feed efficiency:

- Protocols and models further developed and shared (Residual Feed Intake; RFI)
- Between and within-breed variation confirmed
- Moderate heritability estimates across research groups





Residual Feed Intake (RFI)

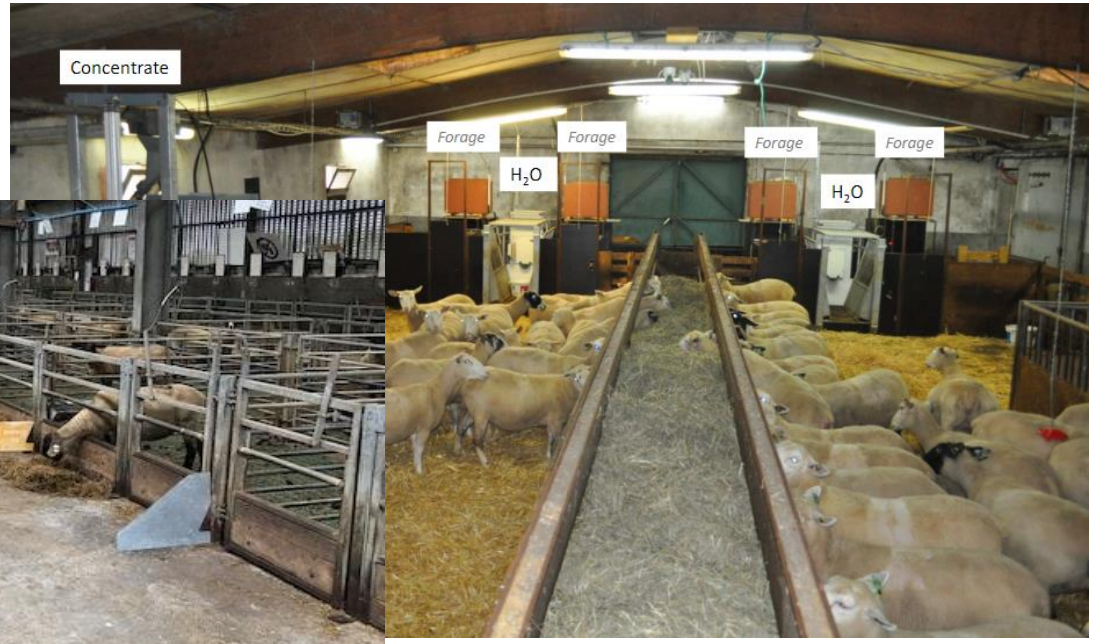
= actual feed intake - predicted feed intake

(due to growth, metabolism, composition changes etc.)

Key progress / findings so far (across partners)

Feed efficiency:

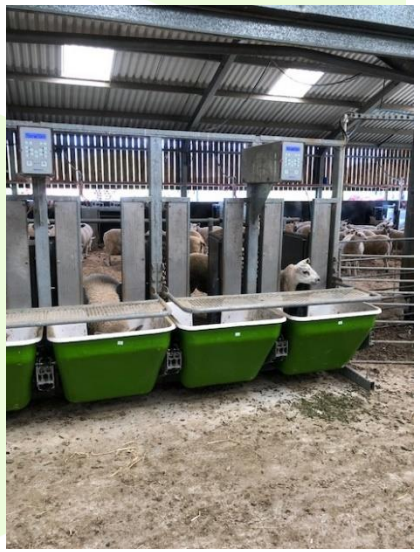
- Differences between forage-based diets (grass / silage of differing quality)
- Positive correlations between indoor concentrate intake, indoor forage intake and RFI
- Feed intake at grazing (n-alkane technique) highly correlated with intake measured indoors

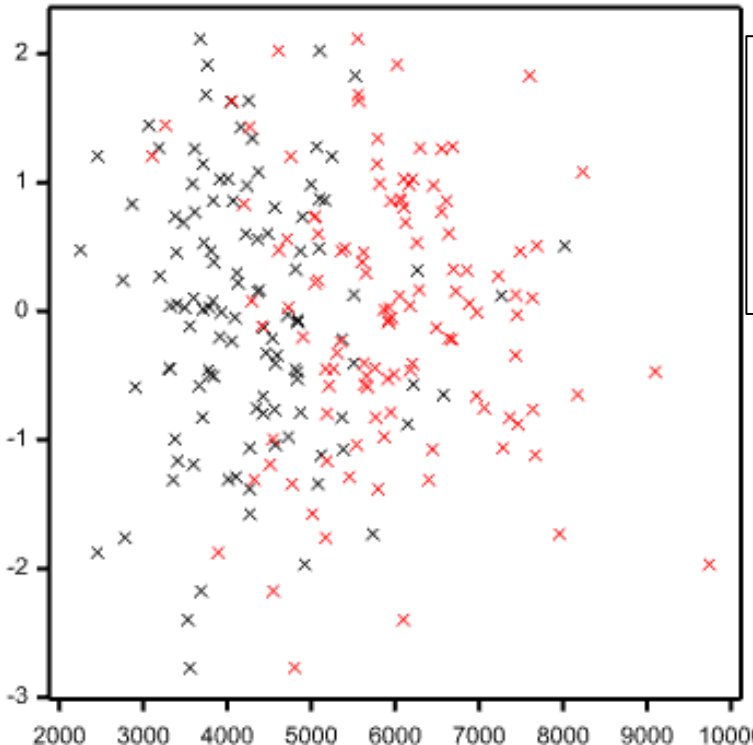


Key progress / findings so far (across partners)

Feed efficiency:

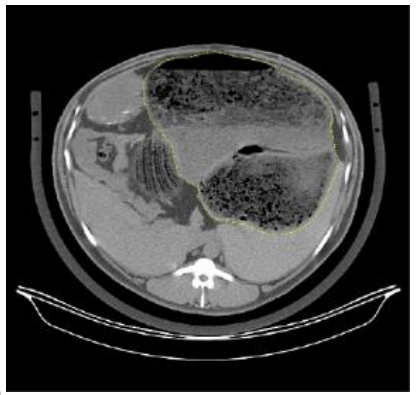
- Feed intake behaviour (no. meals, meal duration etc.) explained large % RFI variation
- No significant relationships with CT-measured rumen volume (prelim. analyses)
- Ruminal microbiota and metabolomics – no clear relationships (prelim. analyses)





x = RFI vs pre-trial rumen vol

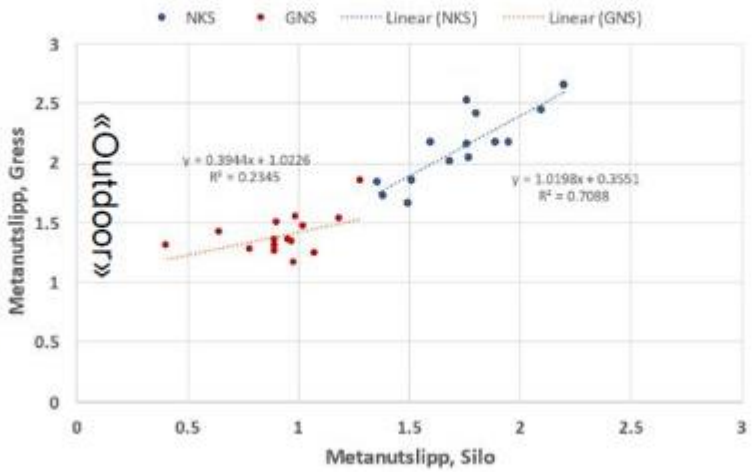
x = RFI vs post-trial rumen vol



Key progress / findings so far (across partners)

Methane emissions:

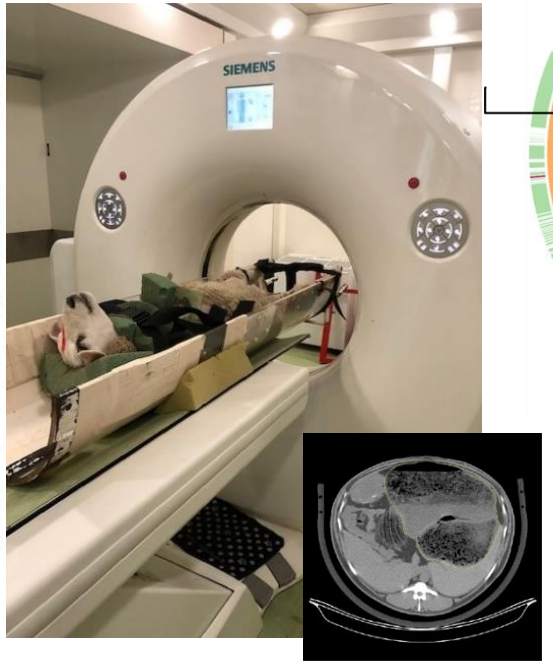
- Protocols and models have been further developed and shared
- Between and within-breed variation confirmed
- Moderate heritability estimates across groups
- Differences due to forage-based diet (silage quality; grass v silage)

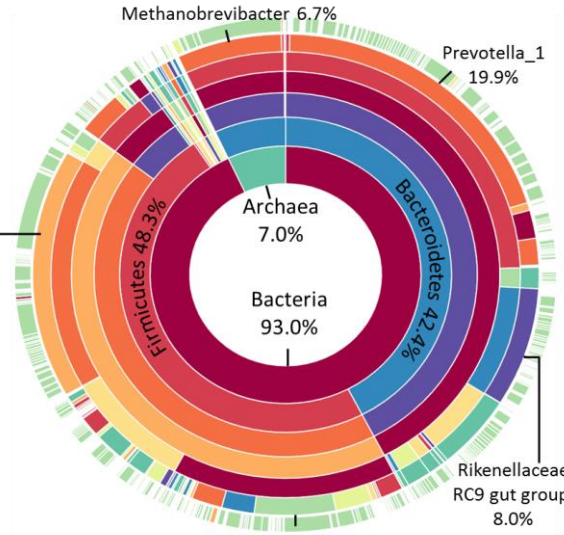


Key progress / findings so far (across partners)

Methane emissions:

- High correlations of PAC and respiration chamber measurements
- High emitters of methane have larger rumens
- Rumen microbiome - genomic sequencing – promising results





agresearch
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Key progress / findings so far (across partners)

Feed efficiency vs methane (CH_4) emissions:

- Preliminary correlations (phenotypic & genetic) amongst:
  - CH_4 emissions (per day)
  - CH_4 yield (per unit DMI)
  - Feed intake
  - Residual Feed Intake (RFI)

- PAC gas emissions (CH_4, O_2, CO_2 + growth) explain large % of feed intake

Conclusions

- Promising tools are being developed to measure traits related to GHG emissions from sheep
- Will enable genetic/ genomic selection for reduced methane emissions
- International collaboration is key:
  - Avoids duplication of research effort / funding
  - Pools expertise
  - Accelerates industry implementation
  - Global problem requires global solution

More information

Twitter: https://twitter.com/grasstogas

Website https://www.eragas.eu/en/eragas/research-projects/grasstogas.htm

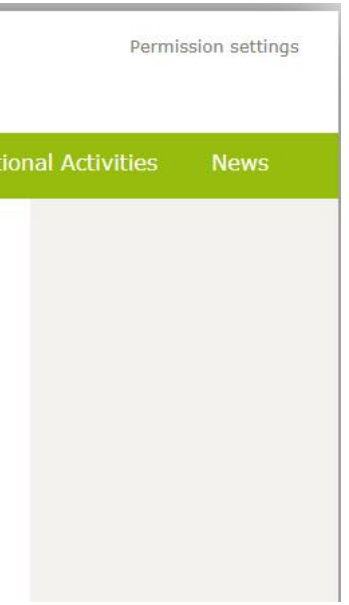
GrassToGas

FACCE ERA-GAS

ERA-NETSUSAN

ICT AGRI era-net

Many thanks!



Website https://

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