



A story of feed efficiency and rumen size

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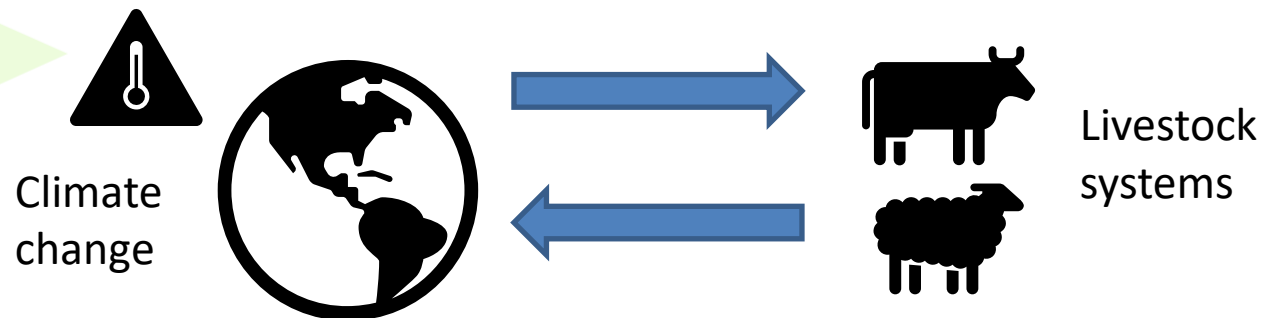


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Genetic strategies - methane mitigation

Genetic solutions:

- a) Breeding for improved productivity / reduced waste
- b) Breeding for feed efficiency
- c) Breeding for direct reductions in methane emissions
 - Measuring methane directly
 - Proxy measures – to accurately predict methane / rank animals



Some phenotypes under research in sheep:



- Individual feed efficiency
 - Indoor - automated feeders, individual pens
 - Outdoor - n-alkanes, sensors/ bite meters, faecal NIR...
- Methane emissions
 - Respiration chambers
 - Shorter-term methane measures:
 - Portable accumulation chambers, extraction hoods, sniffers, laser detectors ...
 - Proxy measurements linked to rumen function:
 - Rumen volumes, rumen microbiome, rumen metabolites ...



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Feed intake recording



water crates



Concentrate crates



16x roughage troughs
Grass nuts
Ad lib

- Up to ~125 lambs per module (1 pen)
- 2 weeks training
- 6 week feed intake trial



Potential to select for feed efficiency



Evidence of variation in feed efficiency of sheep:

- Growing lambs classified as high or low for feed efficiency (RFI) using automated feeders

Study	RFI group differences	
	Feed intake	Live weight gain
Redden et al. 2013	15%	NS
Cockram et al. 2013	30%	NS
Johnson et al. 2015	20%	NS

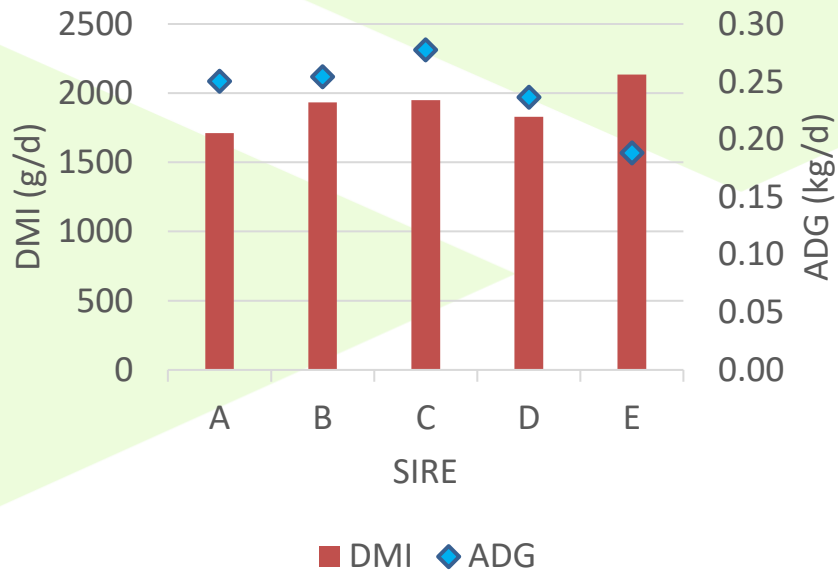
NS = not
significantly
different
($P > 0.05$)

Residual Feed Intake (RFI)
= actual feed intake - predicted feed intake
(due to growth, metabolism, composition changes etc.)

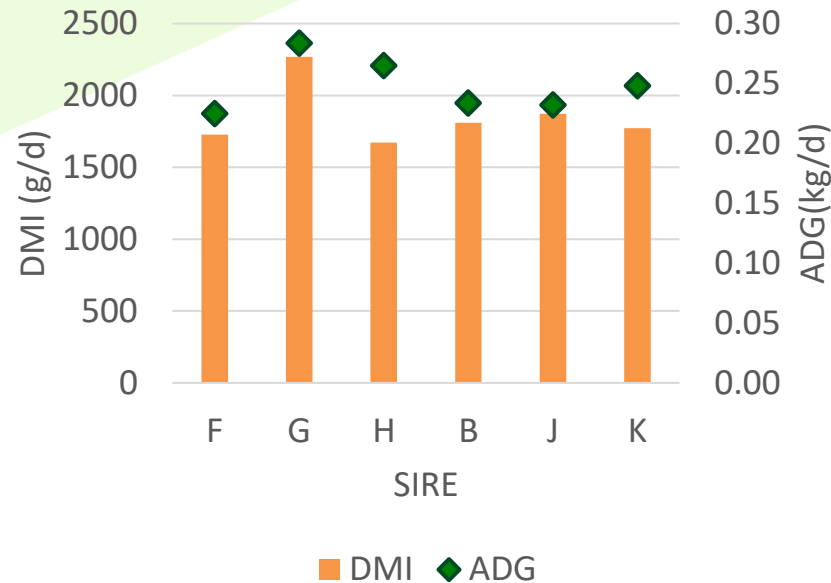
Grass To Gas project – FI & CH₄

- Texel x Mule finishing lambs (n = 239)
- Recorded for feed intake (forage-based diet)
- CT and ultrasound scanned at start & end
 - body composition (efficiency); rumen volume (methane predictor)

2021 - Preliminary results per sire



2022 - Preliminary results per sire



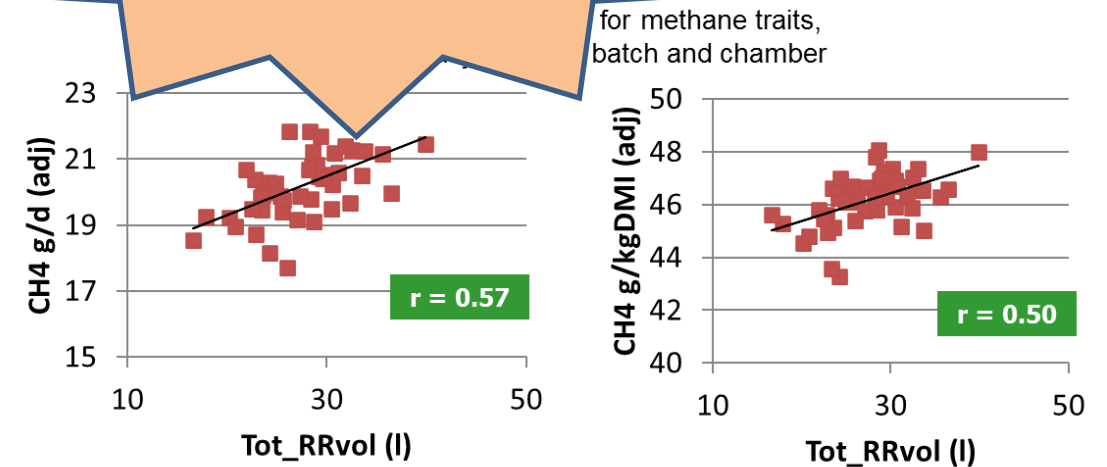
Reticulo-rumen volume (RRvol) vs methane



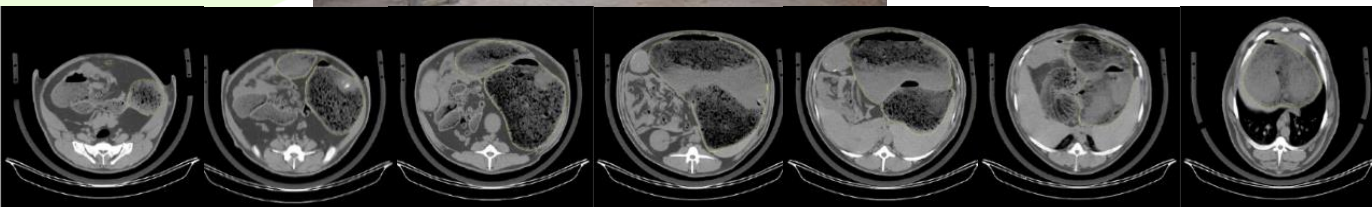
• NZ - 3 generations of selection to reduce methane (Rowe, 2021)

- 20% difference in RRvol between lines
- associated with 11% difference in methane emissions

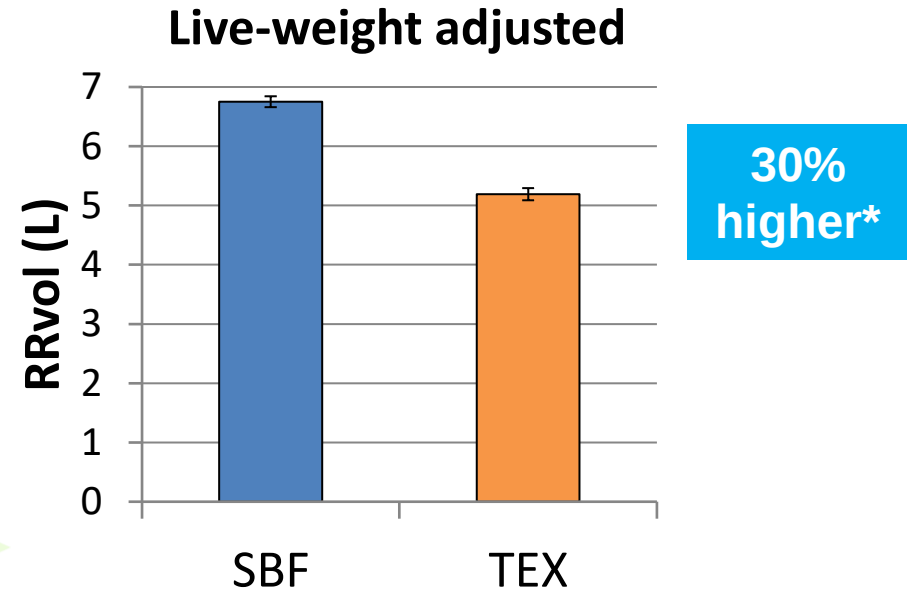
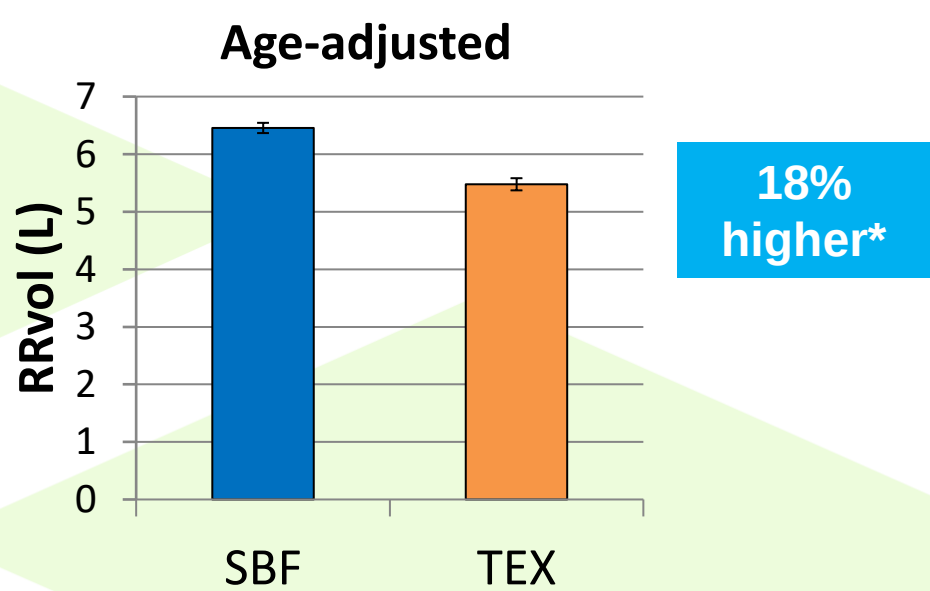
Bigger rumen
= more methane



CT reticulo-rumen (RR) volume
related to CH₄ emissions



Breed effect on rumen volume (RRvol)



* P<0.001



- Texel
- Scottish Blackface

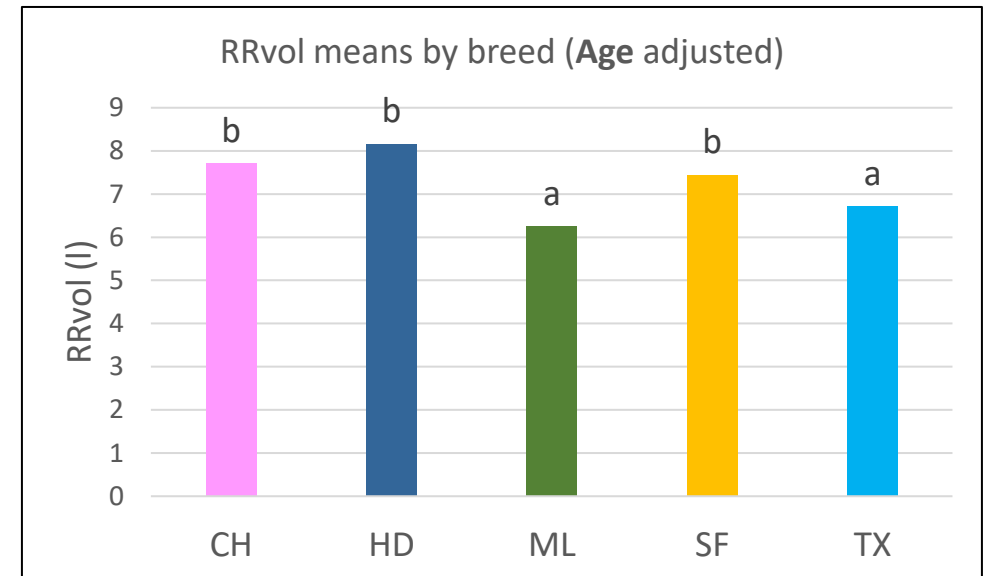
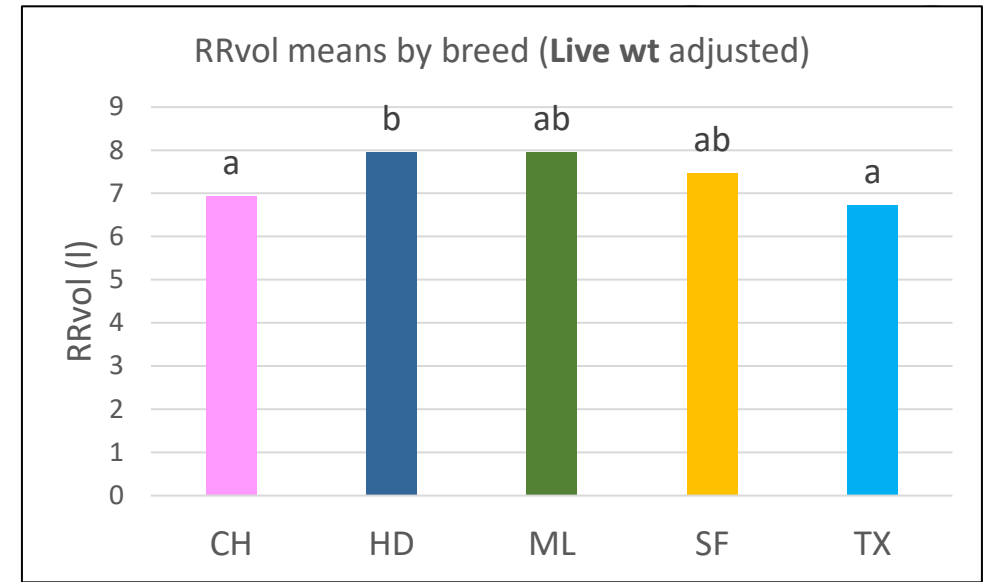
Sire

Terminal sire breed differences in RRvol



Breed	n	
	lambs	flocks
Charollais (CH)	129	16
Hampshire Down (HD)	102	15
Meatlinc (ML)	98	4
Suffolk (SF)	106	14
Texel (TX)	265	34

- Significant breed differences in RRvol ($P < 0.05$)



Genetic effects on rumen volume



- Rumen volume measured from routine CT images
- Moderately heritable in Texel lambs ($h^2 = 0.45$)
 - potential for genetic selection within-breed?
- Genetic relationships with other economic / environmental traits?
 - Favourable: carcass traits (lean yield, dressing %) vs RRvol or CH_4
 - Animals inefficient at digesting fibre produce less CH_4 (Cabezas-Garcia et al., 2017)
 - Different priorities in different production systems?



New phase of hill sheep selection



Scottish Government
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- **High index Scottish Blackface (SBF)**
- **Crossing SBF x Lleyn**
- Selection for:
 - Production
 - Health and welfare
 - Resilience
 - Efficiency
 - Reduced environmental impact
- Monitor:
 - Grazing resource
 - Animal location
 - Biodiversity
 - Environmental parameters (sensors)



Breeding sustainable hill sheep (2022-27)



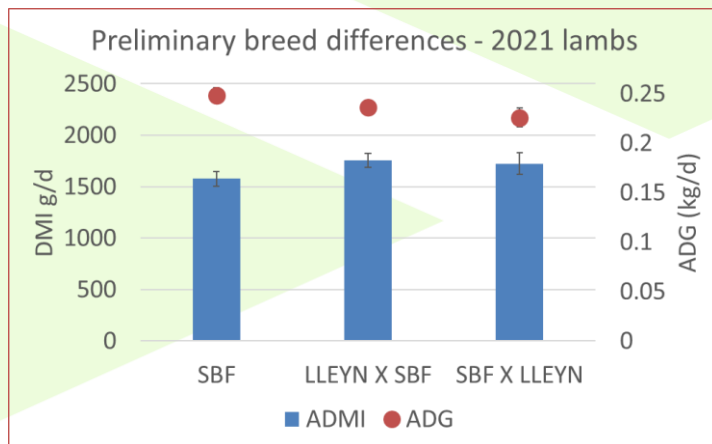
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- Individual feed intake data on ~120 weaned ram lambs/yr
- CT scan data collected before & after 6 wk feed intake recording
 - carcass composition and rumen volume (methane predictor)



- GPS and activity tracking of ewes on the hill

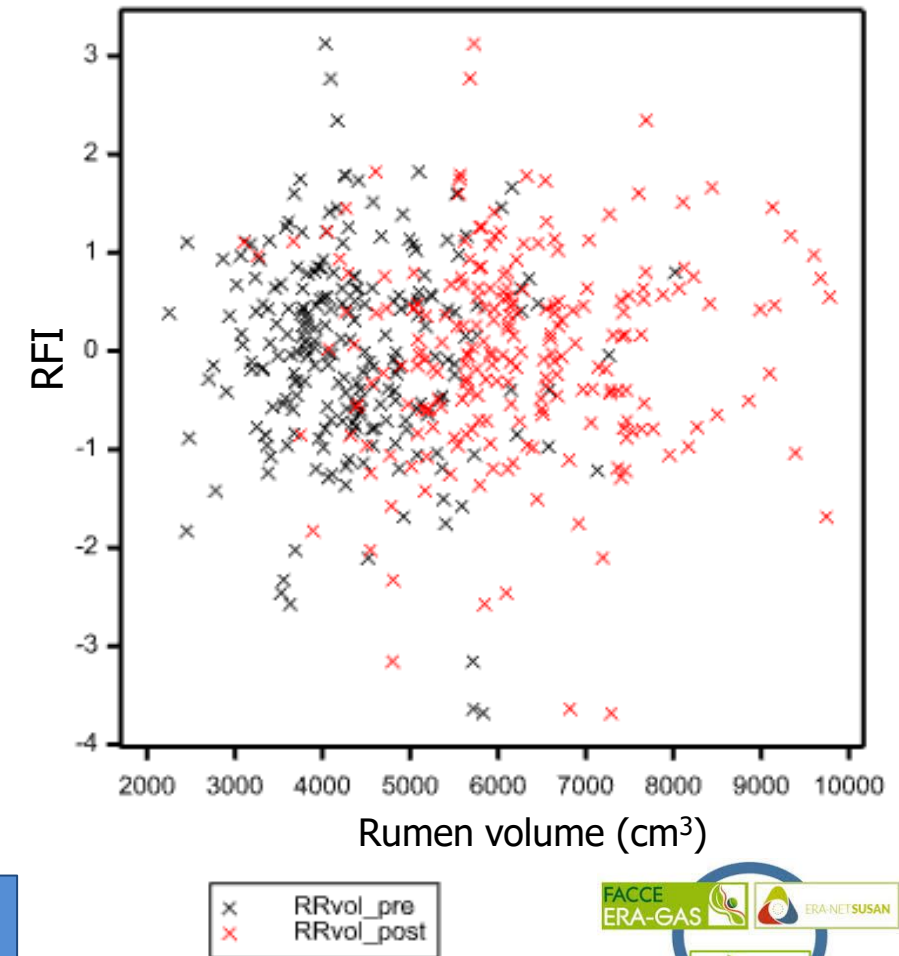


Scottish Blackface vs Lleyen x Blackface; individual differences of most interest for genetic selection

Rumen volume (RRvol) vs feed efficiency



- No sig. affect of RRvol (before or after feeding trial) on:
 - Residual feed intake (RFI)
 - Average daily number of meals
 - Average dry matter intake per meal
- Variation in RFI:
 - 65% explained by average daily number of meals



Residual Feed Intake (RFI)
= actual feed intake - predicted feed intake
(due to growth, metabolism, composition changes etc.)



Conclusions



- Promising tools to measure traits related to efficiency, resilience and GHG emissions from sheep
- Research is enabling:
 - understanding of genetic relationships and trade-offs
 - appropriate genetic selection for these traits in future indices
- International collaboration: avoids duplication of research effort /funding; pools expertise; accelerates industry implementation
- Climate change is a global problem that requires a global solution



Acknowledgements



Thanks for your attention!

