Tools to breed sheep with lower methane emissions

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Some phenotypes under research in sheep:

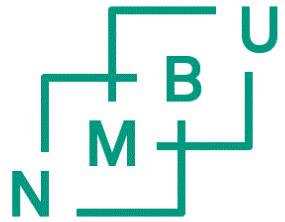
- Individual feed efficiency
  - Indoor - automated feeders, individual pens
  - Outdoor - n-alkanes, sensors/ bite meters, faecal NIR…
- Methane emissions
  - Respiration chambers
  - Portable accumulation chambers
  - Rumen volumes
  - Others – SF6, microbiome…

Grass to Gas (2019-2023):

Strategies to mitigate GHG emissions from pasture-based sheep systems

Objectives:

- Validate predictors of **feed intake / efficiency** and **methane emissions**
- Determine the relationships between:
  - indoor vs outdoor (grazing) feed efficiency
  - indoors vs outdoors methane production
  - FE vs methane production – indoors and outdoors
- Investigate genetic & genomic strategies to reduce methane from pasture-based sheep systems
- Quantify economic and environmental benefits
- Deliver applied, sustainable solutions to reduce methane emissions from sheep



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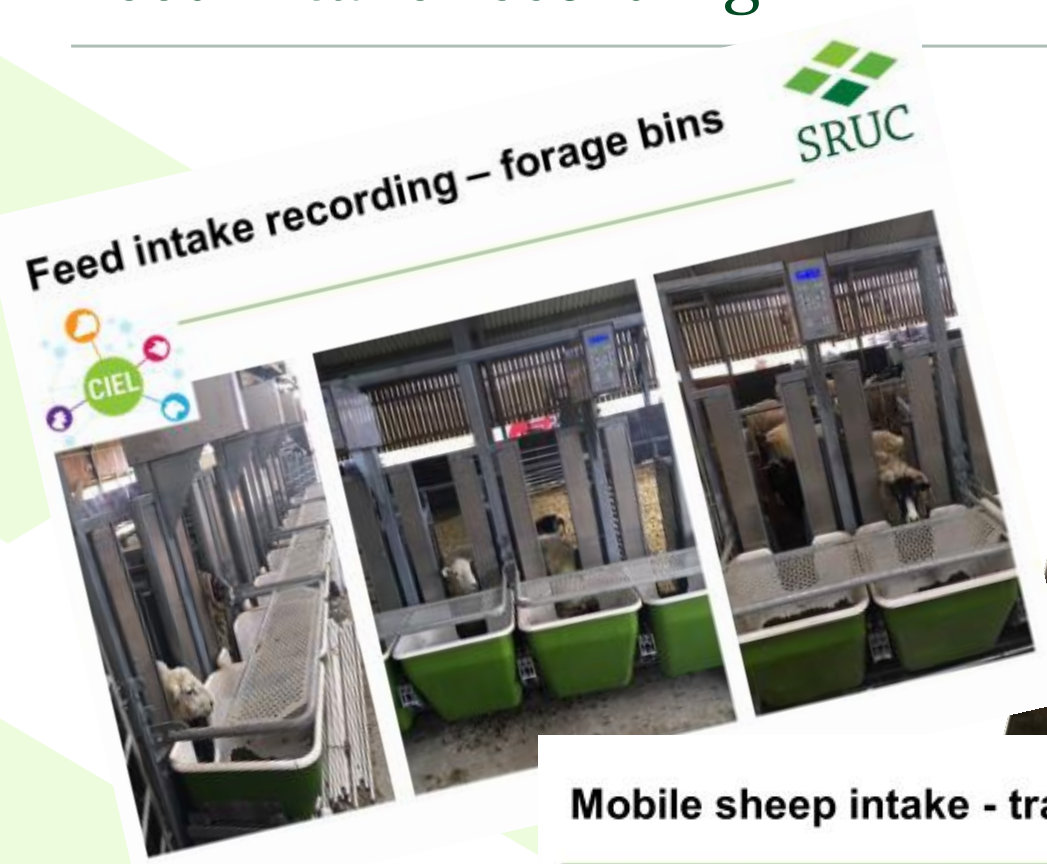
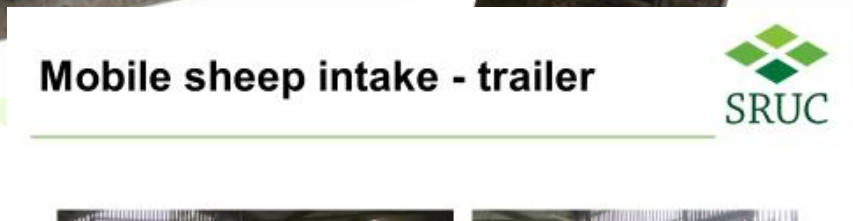
Feed intake recording





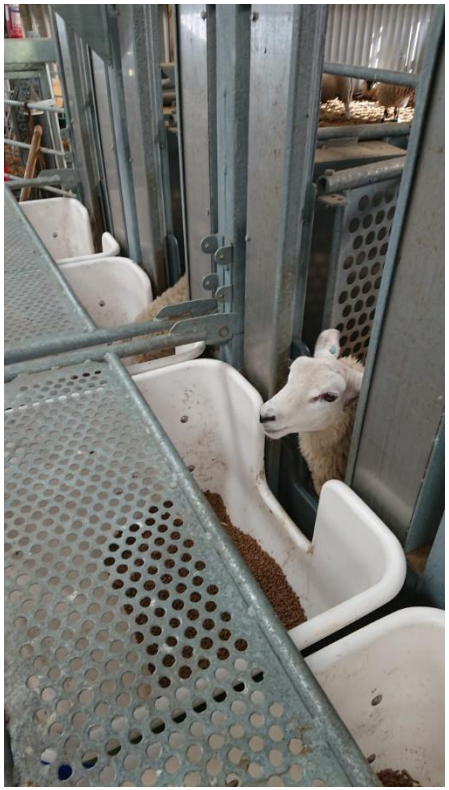
2 Pilot Trials at SRUC Kirkton

Pilot 1

- Jan-Mar 2018
- Setup and test
- Can individual differences be recorded?

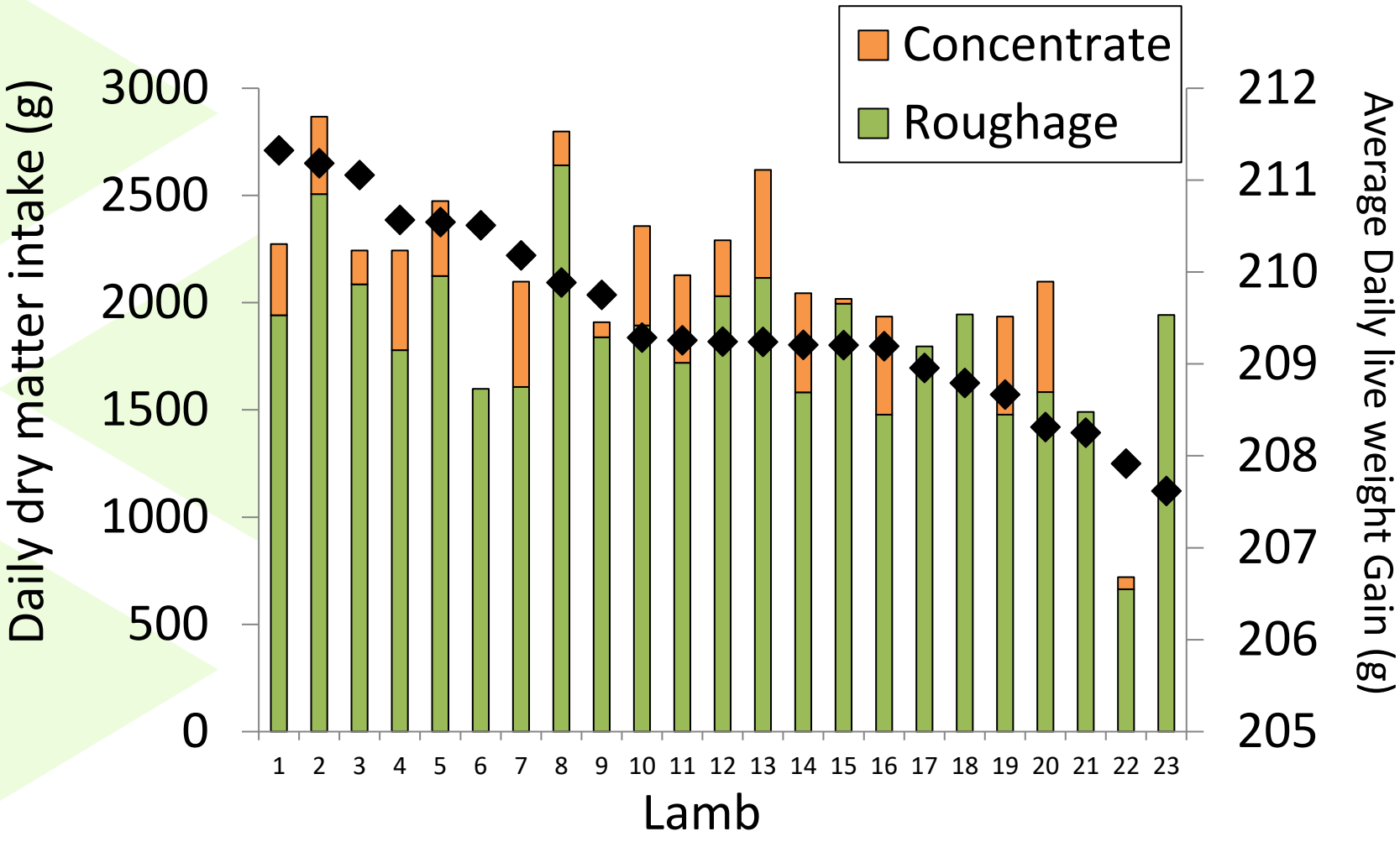
Pilot 2

- Aug-Dec 2018
- Finishing male lambs
- Identify feeding behaviour and efficiency differences



Pilot 1 – Shed setup

Pilot 1 - Intake and gain by lamb



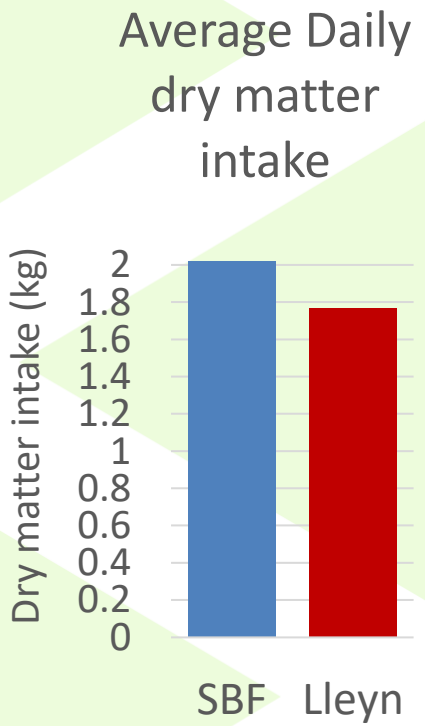
Pilot 2

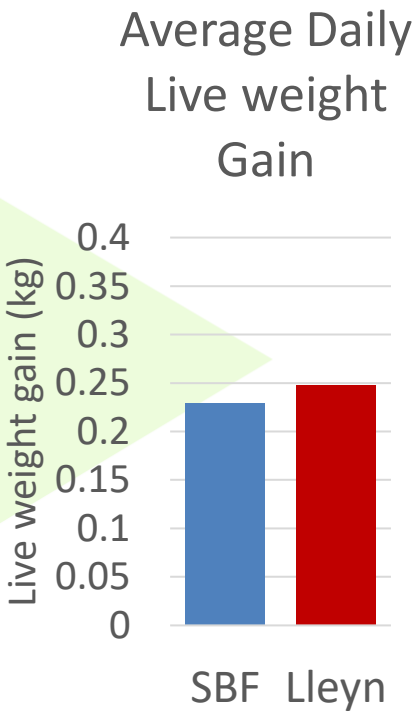

2x water crates
16x roughage troughs
Finishing pellets
Ad lib

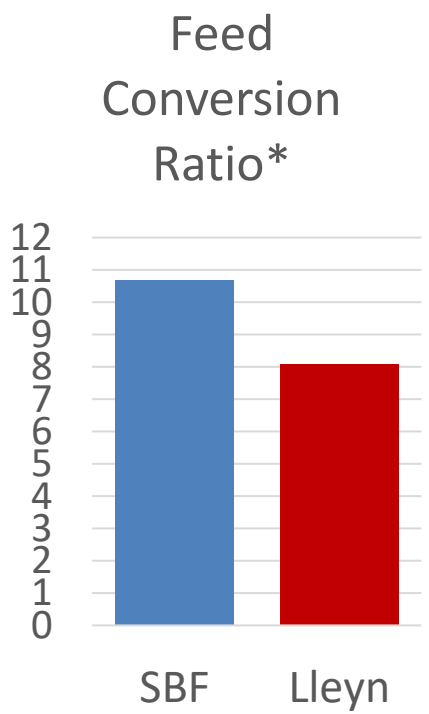
Pilot 2 – Trial design

- 120 male finishing lambs
  - 75% Scottish Blackfaces
  - 25% Lleyn
  - ~4 months old
  - Ave. 24.3kg at start

Pilot 2 – Breed comparison

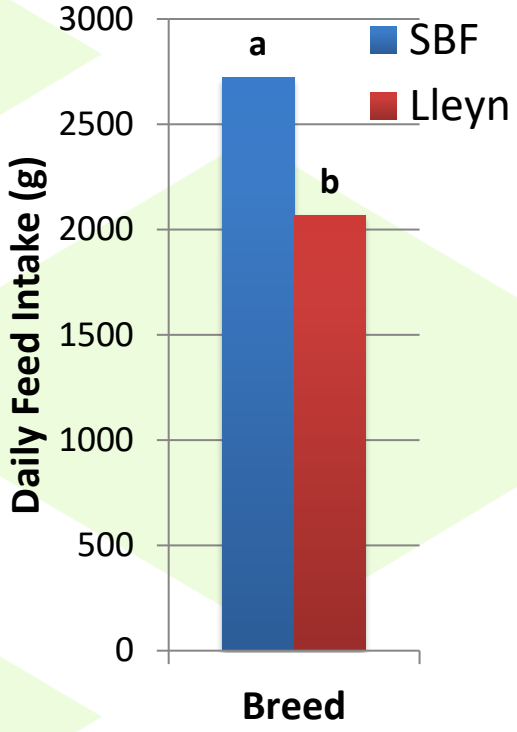






*kg feed per kg live weight gain

Pilot 2 - feeding behaviour



Rachel Gately, BSc Hons dissertation, 2019

Scottish Blackface:

- ate more concentrates per day
- spent longer feeding
- were responsible for 95% of bullying events
  - mounting, head butting, pawing, pushing a lamb in the feeder

Possible effects of mixed-breed management?

Conclusions

Pilot trial 1

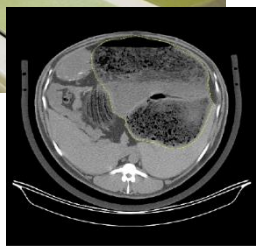
- Variation in intake occurs
- Feed intake can be recorded
- Individual efficiency can be identified

Pilot trial 2

- 7-14 days needed to train lambs
- Can be used for finishing lambs
- Promising data for feed efficiency

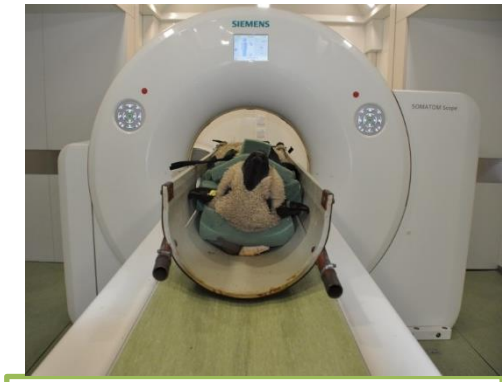
WP1- validating predictors of FI & CH4

- Summer **2021 and 2022**
- Texel x Scotch Mule finishing lambs (n=125 x 2yrs)
  - recorded through feed intake recording equipment
  - 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?

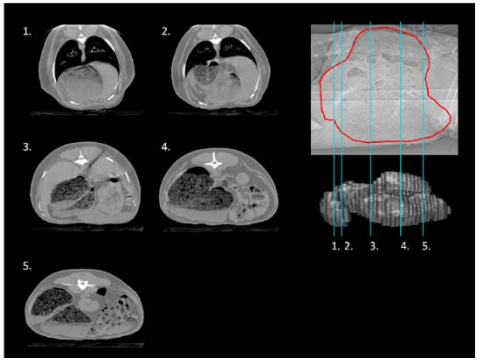


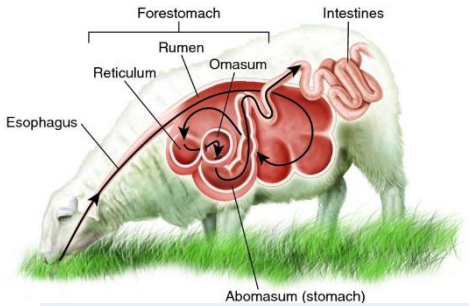
CT rumen volumes – CH_4 predictor

- Different rumen morphology in sheep divergent for methane emissions
  - New Zealand (Bain et al., 2014)
  - Australia (Goopy et al., 2014)
- Bigger rumen = more methane
- Can CT rumen measurements predict methane emissions?
- Are these predictors under genetic control?



Bain et al. 2013. AABG 2013.





Scottish Government
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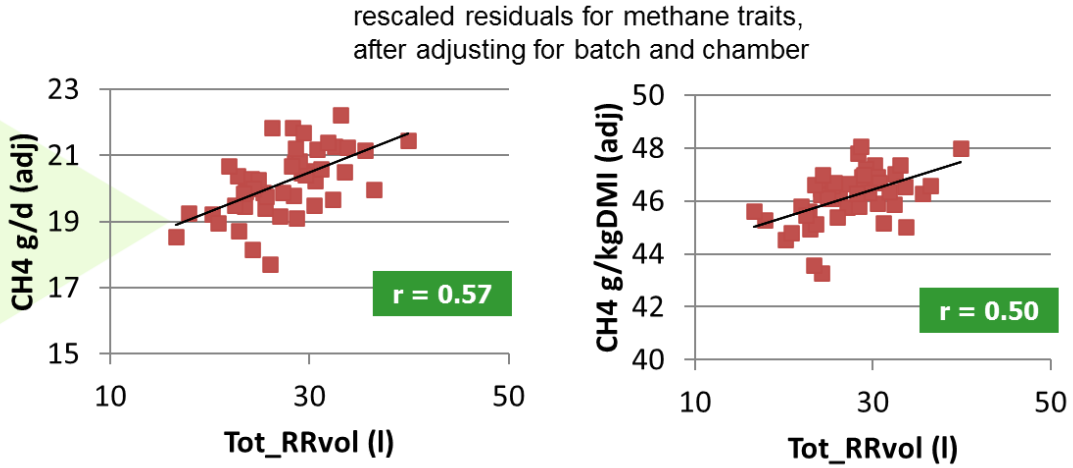
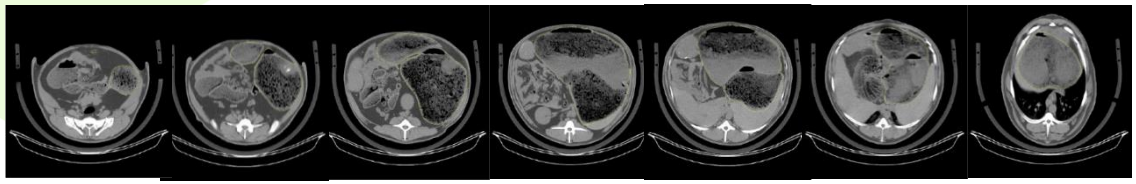
Can CT rumen volume predict CH4?

Lambe, Miller, McLean, Gordon and Dewhurst 2019. Prediction of methane emissions in sheep using computed tomography (CT) measurements of rumen volume. British Society of Animal Science.



CT reticulo-rumen (RR) volume related to CH_4 emissions

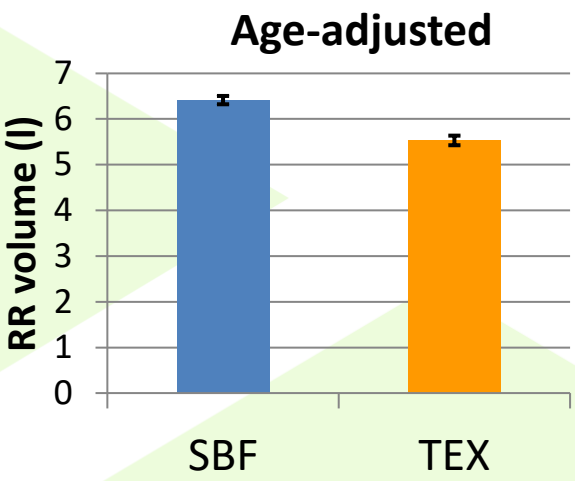


Breed effect on RR volume

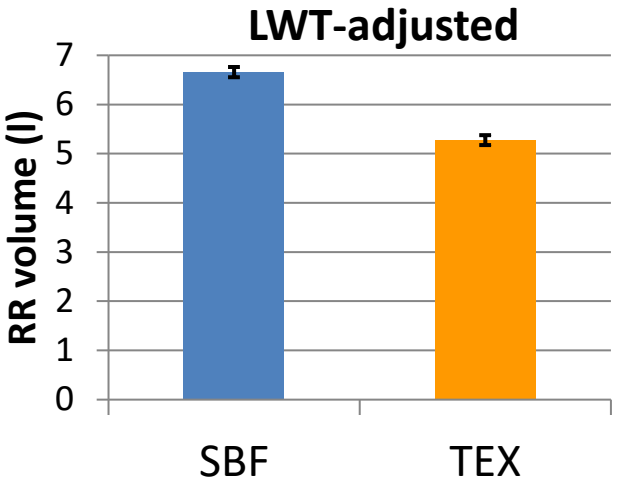
CT archive data set from 220 lambs CT scanned pre-slaughter:

- Scottish Blackface (n = 151) and Texel (n = 119)
  - reared together on low-ground grass birth-slaughter
- Entire male and female
- Age 3 - 6 months (average 20 weeks old)

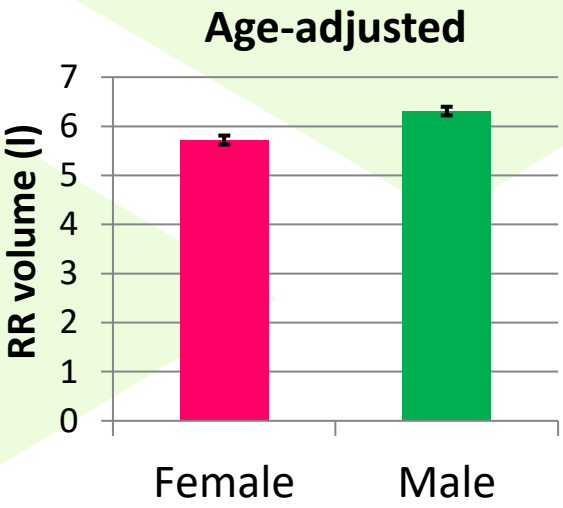
Breed effect on RR volume

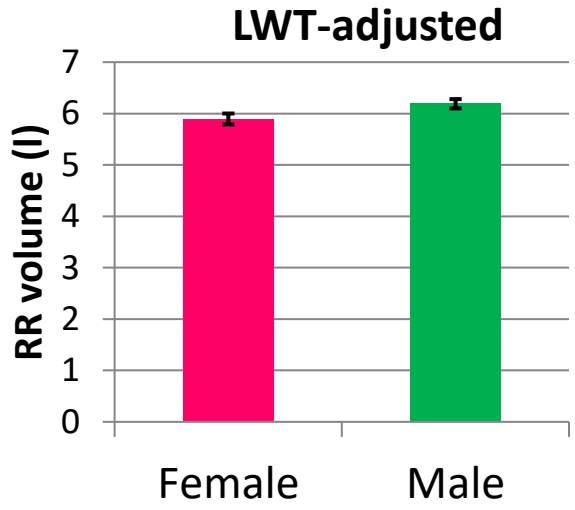


16% higher*



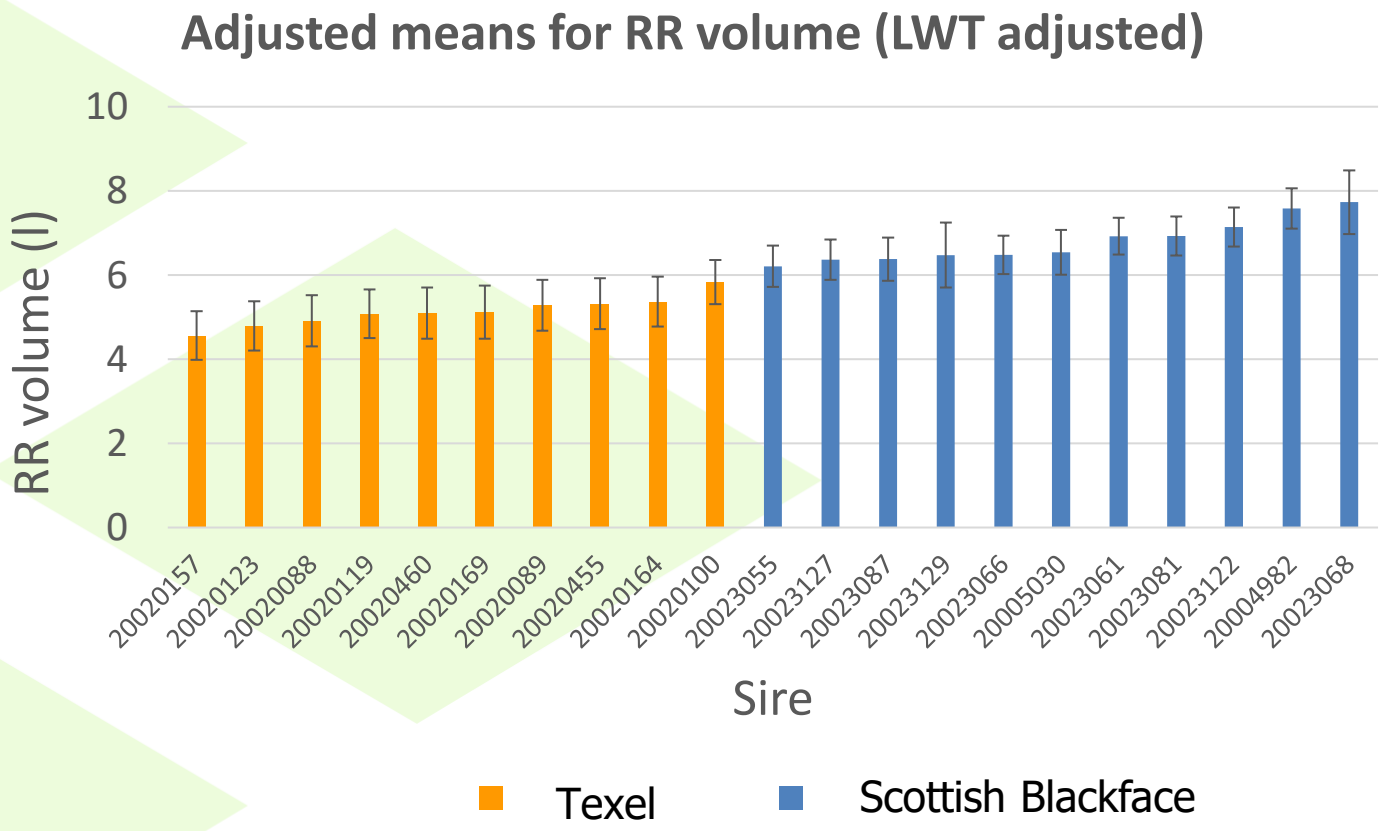
26% higher*





* P<0.001

Sire effect on RR volume



- Significant sire differences, even within breed (P<0.05)

Genetic effects on RR volume

CT archive data set from 649 commercial Texel ram lambs:

- Scanned 2017-2019 for national breeding programme
- From 36 flocks (2 - 38 lambs/flock) and 188 sires (1 – 25 lambs/sire)
- Age 2 - 7 months (average 20 weeks old)
- Live weight 36 – 86 kg (average 55 kg)
- No standardisation of diet or time off feed

Genetic effects on RR volume

Additive genetic variance	σ_a	0.59 litres
Phenotypic variance	σ_p	1.17 litres
Heritability	h^2 (s.e.)	0.52 (0.15)

- Reticulo-rumen volume measured during routine CT
- Moderately heritable in Texel lambs
- Potential for genetic selection within-breed

Considerations

- Valuable additional measurement from routine CT
- High repeatability of rumen volumes measured by CT (Oddy et al., 2019)
- Potential to use for breeding?
- Genetic relationships with other economic / environmental traits?
  - Favourable CH_4 vs carcass traits (lean yield, dressing %, Elmes et al., 2014)
  - Animals inefficient at digesting fibre produce less CH_4 (Cabezas-Garcia et al., 2017)
  - Different priorities in different production systems?

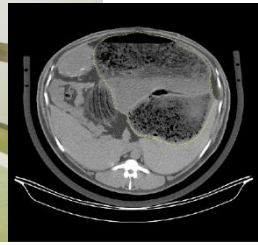
Future work – investigated in G2G

- Further understanding required of the complex relationships between:
  - rumen function
  - methane emissions
  - feed efficiency
  - production

  across different types of sheep systems

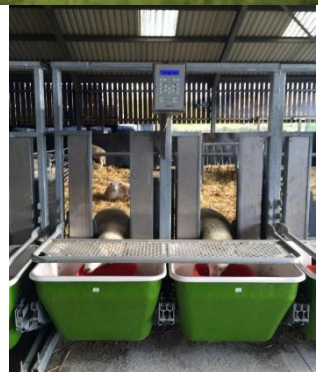
WP2- indoor vs outdoor FE & CH4

- Summer **2021 and 2022**
- Texel x Scotch Mule finishing lambs (n=125 x 2yrs)
  - Siblings of lambs in indoor FI equipment
  - Grazed on pasture
- Record:
  - grazing offtake
  - growth
  - body composition (US all & CT sub-sample)
  - CT rumen volume (sub-sample)
- Related lambs compared indoor/outdoor



WP3- genetics to reduce CH4

- Texel x Scotch Mule finishing lambs (n = 250 x 2yrs)
  - Indoor/outdoor finishing – siblings split across systems
  - Sired by performance recorded Texel sires
    - range of EBVs / indexes
    - strong genetic links to national population
- Identify FE differences due:
  - sire
  - breeding values
  - index value



Portable Accumulation chambers (PAC)

WP4- economic/environmental benefits

- SRUC social scientist – Michael Macleod
- Results from WP1-3 from all partners
- Economic and environmental modelling tools
  - quantify effects of promising tools on FE and CH_4
    - outputs
    - gross margin
    - GHG emissions
  - Cost-effectiveness of genetic / genomic strategies
  - Life-cycle analysis to identify trade-offs

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

Eastbio student seminar, 26 February 2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°772787

Conclusions:

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

Acknowledgements

SRUC

CIEL

TEXEL SHEEP SOCIETY

Signet

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