



Can we measure feed efficiency in sheep?

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Why are we interested in sheep feed efficiency?



- Sheep produce meat from grazing (marginal) land often unsuitable for other agricultural production
- Important for economic, environmental and social sustainability & food security



- Good grazing (seasonally) limited in most systems, supplementary feed given
- The meat industry strives to produce a continuous, cost-effective supply of lamb

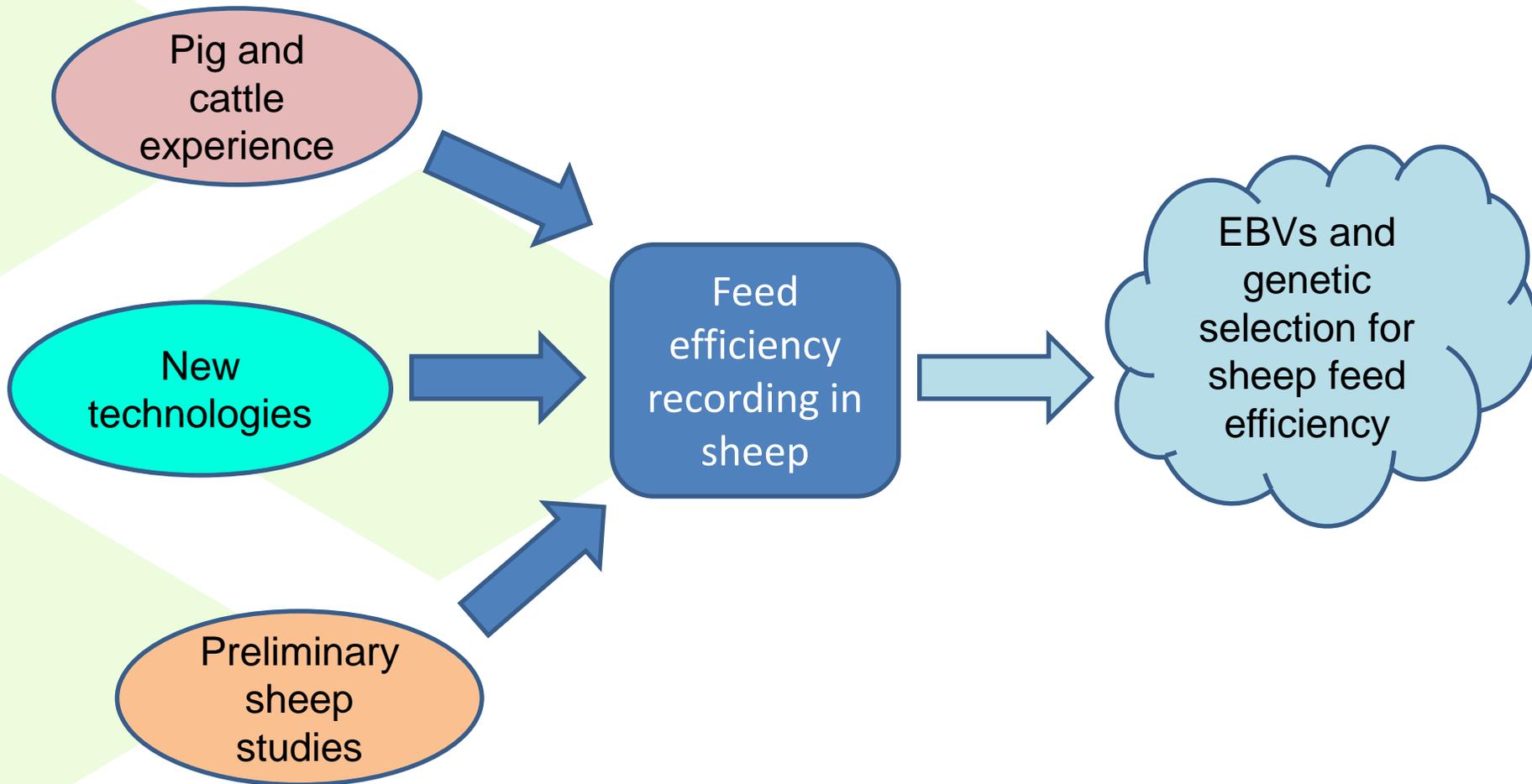
Why are we interested in sheep feed efficiency?



- Feed and forage: ~60% of variable costs across different types of UK sheep production systems
 - growth of lambs to finishing
 - maintenance of breeding ewes
- Increased feed efficiency
 - reduce feed and forage costs
 - more sheep per ha of grass
- Efficient conversion of feed into weight gain / lamb production
- Feed intake is difficult and time-consuming to measure on an individual basis, esp. in grass-based systems



Can we record sheep feed efficiency?



Feasibility of genetic selection



- Genetic improvement to produce more lamb meat using fewer resources
 - requires genetic parameters in relevant breed (1000-2000 animals with feed intake records)
 - no current method sufficiently accurate to measure individual feed intake at pasture in a breeding programme
 - use of EID & automated feeders during performance testing of growing lambs?
 - knowledge gaps in best methodology to allow full expression of feeding behaviour in sheep
 - relationships with feed intake on pasture?
 - relationships with intake in mature ewes?



Review of sheep feed efficiency recording



- Scottish Funding Council, KTE grant
 - desk-based study by SRUC
- Information sources:
 - literature review on feed efficiency in sheep (and beef cattle), focus on automated feeders to record feed intake
 - SRUC/SIG study tour to relevant companies in the USA and Netherlands (ASDA funded)
 - communications with NZ research group designing a similar experiment in a maternal sheep breed



Potential to select for feed intake



Evidence of variation in feed intake of sheep:

e.g. Redden RR, Surber LMM, Grove AV, Kott RW. 2013.

Growth efficiency of ewe lambs classified into residual feed intake groups and pen fed a restricted amount of feed. *Small Ruminant Res* 2013;114:214-219.

Growing ewe lambs classified as having high feed efficiency (residual feed intake measured by automated feeders) could achieve similar growth rates and body weights as lambs with low feed efficiency using 15% less feed (Targhee lambs, University of Montana).

Similar results from other trials, mainly in USA, France, Australia

Genetic control of feed efficiency



- Cattle – meta-analysis of 39 papers (Berry and Crowley, 2013) :
 - Moderate heritabilities for residual feed intake (RFI; 0.33) and feed conversion efficiency (FCE; 0.23), in growing cattle.
 - Low h^2 in mature cows (0.06 for RFI, 0.04 for feed efficiency)

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



- Sheep – less well investigated:

- Moderate h^2 for feed intake, RFI and feeding behaviours (Cammack et al., 2005; Francois et al., 2007; Pulina et al. 2013)
- Low-moderate h^2 for feed intake in grazing (Merino) ewes (Lee et al., 2001; Fogarty et al., 2006; 2009)



Review of sheep feed efficiency recording

- Some recommendations for the use of automated feeders for lamb feed intake recording in literature:
 - Measure feed intake post-weaning
 - 9-11 lambs per feeder
 - 1-2 week adaptation
 - 6-8 weeks on test
 - Forage-based diet
 - Record ~1000-2000 animals at same stage of development for robust genetic parameter estimation
 - Select for (residual) feed intake within multi-trait index



Indoor vs pasture feed intake

- Feed intake in grazing animals affected by diet selection, foraging behaviour, locomotor activity, thermoregulation...
- Methods to measure grazing intake: not sufficiently practical or accurate for breeding
 - alkanes and other faecal markers
 - grazing exclosures, field biomass measurements, forage harvests
- Cattle studies suggest selection for post-wean feed efficiency (using automated feeders & pelleted diet) affects growth and feed efficiency on pasture (Herd et al, 1998; 2002)

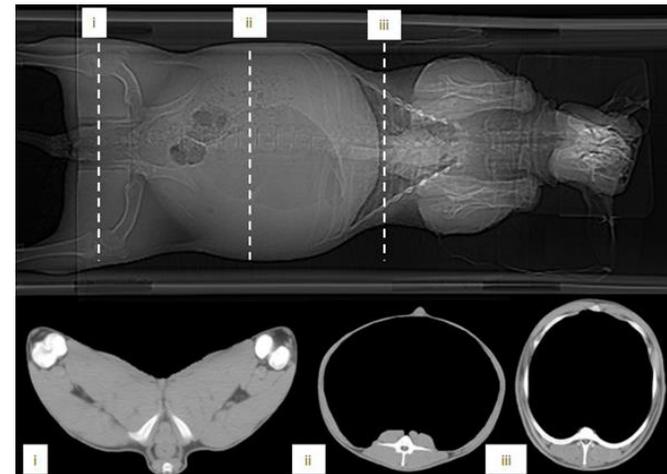


Growing lamb vs mature ewe

- RFI depends on accuracy to estimate the requirements for growth, maintenance and other production
 - changes in body composition with development
- Very little known about the genetic relationships between feed efficiency of growing lambs and breeding ewes
- Cattle (and mouse) trials suggest potential to select for FE of mature females based on measurements taken in young growing animals (Nieuwhof et al., 1992; Archer *et al.*, 2002; Hughes and Pitchford, 2004)
- Conflicting results in the literature (incl. sheep), mainly from smaller, less powerful trials (e.g. Redden et al., 2011; 2013)

Other important findings/considerations

- Cattle - feed efficiency variation largely explained by weight, growth rate, body composition, milk yield and type traits
 - additional genetic gain from measuring feed intake?
- Selection for feed efficiency is likely to reduce fatness (including IMF) at a constant age or weight
 - monitor composition changes (CT scanning)
- Selection for feed efficiency could delay maturity
- Some evidence for reduced methane production in cattle with lower RFI (Hegarty *et al.*, 2007)



Conclusions



- Potential exists to record feed efficiency in sheep
- Research required in relevant UK sheep breeds & systems to:
 - refine methods to measure feed intake (diet; group size/structure; test period; adaptation...)
 - estimate genetic parameters
 - investigate relationships between FE in automated feeders and at pasture
 - investigate relationships between ewe and lamb FE measurements
- Record FE on sheep that are well-recorded, to explore relationships with other traits
 - feed intake, growth, reproductive output and body composition
- Industry-wide collaboration required to share knowledge and equipment

SIG pilot study





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Sheep nutrition and genetic research platform at AFBI Hillsborough

- Important investment within UK CIEL research platform (Centre for Innovation Excellence in Livestock)
- Capital investment to purchase and install automated individual feed and behaviour recording equipment for 150 ewes and lambs under normal group feeding conditions
- In combination with the existing R&D platform at AFBI Hillsborough a wide range of research areas will be addressed including:
 - nutrition/genetic/immune system interactions
 - impacts of anthelmintics
 - genomic markers of feed/nutrient use efficiency
 - impacts of feed additives (for sheep & as a proxy for cattle)
 - impacts of livestock management practices on feed efficiency
- Platform for genetic improvement



Existing facilities & resources at AFBI



6 calorimetric chambers



Main sheep house – group pens for 360 sheep



52 individual pens

+ On-farm research network in upland and lowland environments



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