BREEDING BETTER BEEF & SHEEP

Report from an AFN+ Scoping Study

Breeding Better Beef & Sheep - industry report

This report outlines some of the ways UK beef and sheep farmers are improving herd/flock genetics and breeding for net zero. The report also recommends a path forward for the wider sector and where more work is needed.

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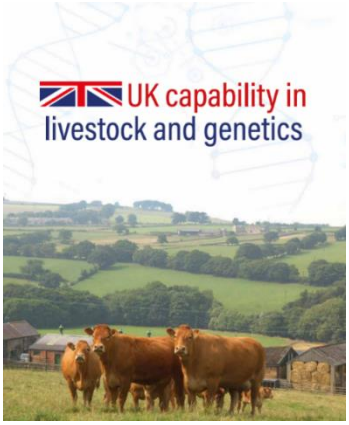
EXECUTIVE SUMMARY



The way we breed livestock has substantial potential to help farms reduce their carbon footprint, specifically by reducing greenhouse gas emissions associated with the way we breed sheep and beef cattle. Breeding sheep and cattle has a long tradition in the UK, which encompasses a multitude of steps from breed choice, individual animal choice, reproductive management, mating strategy, and selecting and rearing replacements. Whether selecting breeding animals based on phenotypic traits, breeding indexes and genomics, ensuring they are healthier and more productive over their lifetime indirectly contributes to net zero emissions. Using technology to enhance genetic improvement, using locally adapted breeds to convert grass to meat in a low input system or rearing animals more efficiently and finishing them quicker all have the potential to contribute to net zero.

Many of our native breeds such as Aberdeen Angus, Hereford, Romney and Suffolk are well established across the world, and some of the globally leading genetic companies started business here in the UK [1]. The UK was the first country in the world to market female sexed semen for use in the dairy sector [1] and we are part of world-leading research into developing and breeding ruminants that produce less methane and convert feed more efficiently [2].

However, compared to the dairy sector, the use of breeding technologies such as genomics, artificial insemination or embryo transfer is not as widespread across commercial beef and sheep farms. This partly stems from the vast variation in farming systems across the sector and tight margins leaving little room for investment. Furthermore, there is less uptake of industry decision-support tools like breeding indexes, despite substantial evidence supporting their use. There are of course many approaches to breeding livestock and genetic improvement, but with fragmented guidance for farmers about the best ways to contribute to net zero farming through improved breeding, it can be very confusing. This project aimed to reduce the noise and identify the most promising ways to breed sheep and beef cattle that contribute to net zero, whilst also being cost-effective, practical and good for animal health and welfare. A cross-cutting industry-academia collaboration was formed from all four devolved nations to provide clarity to this area. It was funded by a UK Research and Innovation (UKRI) network called Agri-food for Net Zero Network+ (AFN+), which aims to help the agri-food sector navigate the challenges of achieving net zero.

KEY FINDINGS

A key finding of the work was that there is not a universal "one size that fits all" solution. Developing a breeding and genetic improvement strategy that fits the specific farming system and farm context is needed for it to be economically, environmentally, and socially sustainable. Farmers have to balance multiple goals when making breeding decisions, such as profitability and making a living.

Net zero is a simplistic, one-dimensional metric of environmental sustainability. Greenhouse gas (GHG) emissions are not the only measure of environmental sustainability farmers are considering. Some approaches to breeding better deliver more holistic benefits than others, such as reduced need for inputs like bought-in feed, and certain breeding and genetic improvement strategies have potential negative impacts on net zero that are not always transparently accounted for in carbon audits.

Many different beef and sheep breeds, from pedigrees, natives, continentals and crosses, are used and can have positive impacts on reducing GHG emissions. In this study, there was evidence for a variety of systems and strategies, whether that was finishing animals quicker with a focus on breeds and traits that give faster growth rates, or selecting cattle/sheep that thrive in outdoor environments with minimal intervention and high rates of fertility.

Two key areas of focus for net zero breeding were selecting animals that are efficient converters of feed and resilient healthy animals that thrive in their environment.

Nevertheless, there were some challenges to consider.

1. There is plenty of data in the industry for informing better breeding decisions, and much of it is being *well* used (e.g., performance records and breeding indexes), but it is not *widely* used. Its application is unequally distributed across the country and across the multitude of farming systems that exist in the UK. This has restricted its adoption and perceptions of its usefulness.

2. Breeding information services provided by industry and academic groups are not being fully utilised. Increased efforts to develop breeding information services *with* different groups of farmers and farming systems is warranted to improve the perceived relevance and trust in them.

3. There may be some initial short-term increases in costs attached to investing in genetic improvement and breeding better cattle and sheep, but it was widely accepted that the benefits arising from genetic gain are cumulative year-on-year, permanent and wide ranging for other facets of the farming business.

APPROACH

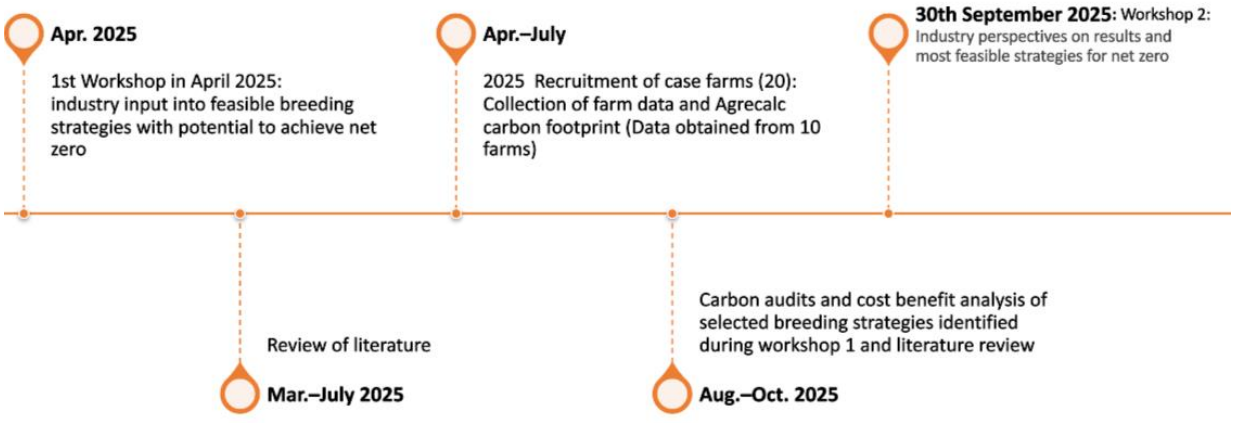
In this scoping study, we brought together four farming industry stakeholders with four different academic institutions for the first time to work out how best to breed beef and sheep that contributes to net zero emissions.

Below are the named partners in this study

- Royal Agricultural University (lead)
- Aberdeen Angus Breed Society
- British Texel Sheep Society
- Harper Adams University
- Hybu Cig Cymru (HCC)
- Mentera
- Quality Meat Scotland
- Queens University Belfast
- Scottish Rural University College (SRUC)

We sought to review the existing published literature on breeding for net zero, and the current perceived wisdom and best practice on beef and sheep farms across the UK. Based on this, as well as some preliminary modelling of the costs versus the benefits when breeding for net zero, we aimed to identify breeding strategies with wins on multiple fronts.

The following diagram shows the overall approach taken and project timeline. More information on the background to the study and detailed approach can be found at the end of the report.



CURRENT STRATEGIES TO BREEDING BEEF AND SHEEP

Cattle and sheep breeding goals can be categorized intro three levels and are being balanced simultaneously by farmers

INDIVIDUAL TRAIT LEVEL

This consisted of breeding to optimise output and resource efficiency parameters, such as lamb survival, lambing percentage, easy lambing and calving with minimal intervention, and the reliance on good mothering abilities. Traits such as high fertility, feed conversion, and disease resilience were often quoted as key as well as quiet temperaments. All these breeding goals are linked to easier, more efficient management, which comes with fewer costs and higher productivity.

BUSINESS LEVEL

The second breeding goal that was balanced with individual traits was business interests, such as a good end sale price or market value, making a living and managing costs. There was much discussion on efficient low input systems such as low input ewes and animals that paid their way.

FARMING SYSTEM LEVEL

The third and final breeding goal was the consideration of the farming system. Sheep were being bred to fit into low maintenance systems where “stock lives and thrives”. Cattle had to have good longevity, milk well and feed efficiently off grass as much as possible. Reproduction had to be managed in tight blocks, and breeding strategies often made use of hybrid vigour and cross-breeding. Breeding goals often favoured developing systems that utilise grass and conservation grazing, so animals needed to be able to calve or lamb outside with easy temperaments, sometimes favouring native, locally adapted breeds. There was recognition, however, that there was not one size that fits all. Housing animals and breeding for efficient growth and finishing quickly was also popular, especially when considering net zero.

Current approaches to genetic improvement and breeding were hugely diverse – there is no one size fits all

1. Two broad approaches were proposed by stakeholders as beneficial for net zero. However, they represent two very different systems. The first approach focuses on finishing animals quicker and more "efficiently" in terms of per kg of CO2 output with bought-in feed, often to certain market specifications. The second approach prioritized less inputs, feeding off grass, and slower growing breeds as part of a holistic system with other environmental benefits. These systems were often seen as opposite approaches but equal in benefits for net zero.
2. Recording and benchmarking performance was deemed valuable across systems, but there was a large variation in how this was done and to what extent. Some breeds were better serviced for breeding indexes than others (e.g., Texels) and within breed/flock/herd variation was significant.
3. Cross-breeding for lambing/calving outcomes, growth, feed efficiency and disease resilience was popular.
4. Pedigree breeding for certain traits and supplying crosses for replacements, stores and finishing herds/flocks was deemed important by some stakeholders, but not to the detriment of animal performance.
5. There was mixed use of reproductive technologies, such as artificial insemination and embryo transfer and they were mainly talked about by pedigree breeders. Natural mating was prevalent across systems and sectors.
6. There is a growing role of dairy bred cattle in the beef supply chain, and growing appeal of rearing store lambs, especially in Wales, but significant uncertainty as to where the emissions from these enterprises were being accounted for.

A key challenge with breeding better beef and sheep for net zero was the limited use of breeding data like breed indexes and genomics

In the devolved nation workshops, there was a perception of being overloaded with general breeding data (i.e., phenotypic, genotypic data and Estimated Breeding Values) that could help inform breeding decisions and ways to reach net zero, but at the same time, there was not enough trusted or farm-specific data available for farmers and advisors to use confidently. There were many in the industry who were exasperated at the lack of on-farm data collection, use of freely available data like breeding indexes using Estimated Breeding Values (EBV) or genomically tested breeding animals. Some farmers in the workshops did not feel they had the time to use industry data and make changes to how they did things on-farm, especially when struggling with spiraling costs and keeping the business profitable.

Stakeholders wanted measurements and data that captured efficiency gains AND ecosystem benefits. There were many things they could and did measure (daily live weight gain, feed conversion ratios, lambing percentage, disease resilience etc.), but there was uncertainty as to which were the best measures, especially when considering net zero. Most stakeholders were dismissive of carbon tunnel vision and the oversimplification of net zero; stakeholders looked at the issue of emissions from farming activities in a more holistic light which involved feed source, soil health, carbon sequestration and biodiversity.

Future areas for Research and Development (R&D) identified by the participants were:

- Understanding carbon sequestration and the relationship between grazing grass, soil organic matter and land utilisation, and including that in discussions around net zero
- Genomic data – breeding for health and the need for better understanding of the variation within and across breeds
- Reducing waste and inefficiencies within and across systems
- Gene editing – uncertainty as to where this fits in?

CONCLUSIONS

The perceived wisdom from the devolved nation workshops was that most of the impact on net zero from better breeding of ruminants was indirect (i.e., through improved numbers of offspring, enhanced growth rates, less disease, inefficiencies and better feed conversion).

The application of breeding data (i.e., on-farm records for monitoring breeding performance and using EBV and GEBV for selecting replacements) is not common, uniform or particularly well joined up across the beef and sheep sectors, especially compared to dairy.

However, there are many examples of good practice, such as the genomic Texel breed economic indexes and AHDB's RamCompare. The variation across and within breeds and between systems is vast, which was not a surprise. Some breed-specific schemes were highlighted as helpful for measuring impact on net zero whilst offering economic opportunities for some farms e.g., Aberdeen Angus breeding schemes. Reproductive technology use was primarily found across those in the cattle sector and appeared limited to artificial insemination and sexed semen, with some embryo transfer being used. There was general uncertainty as to how much the technologies contribute to achieving net zero. Ultimately, animal breeding was seen as just one small part of a bigger picture.

WHAT DOES EXISTING PUBLISHED LITERATURE SAY?

The eight primary means of improving the genetic merit of the herd/flock according to the published literature were:

- Reproductive management
- Efficiency
- Longevity
- Health
- Selecting replacements
- Breed selection
- Farm data
- Breeding animals with fewer emissions

Within each of the above categories, there were several different strategies, some of which had substantial evidence behind them about how they linked to achieving net zero emissions, and others less so. For instance, in the category of efficiency, there were numerous examples of a direct impact on net zero emissions ranging from strategies to lower residual feed intake, improve feed efficiency, reduce days to slaughter and optimise carcass balance [3-6]. Overall, breeding cattle and sheep were similar in their approaches but differed the most around the strategies to improve longevity. In cattle this centered around health and resilience, whereas in sheep, this was broken down into lifetime performance of ewe and offspring performance in lambs.

Tables One and Two outline the types of beef cattle and sheep breeding strategies discussed in the published literature and the weighting of evidence behind them for contributing to net zero. Each column represents one of the eight breeding categories mentioned previously, and the rows are the different strategies found within these. Strategies in bold have an index associated with them and blue cells demonstrate evidence of a direct link to net zero, orange cells an indirect link. Circled cells represent the highest expert ranking for potential to achieve net zero.

This is not an exhaustive list - we may have missed something, and there are many commercial genetics companies that have ongoing work in this area (e.g., reduced methane emissions trait development) that is not yet in the public domain.

CONCLUSIONS FROM SCOPING REVIEW OF THE PUBLISHED LITERATURE AND EXPERT RANKING OF IDENTIFIED STRATEGIES

1. Evidence is limited for the link between breeding and net zero; strategies with no identified evidence could still contribute to net zero/reduced emissions.
2. EBV/Indexes/GEBV already exist for strategies with most published evidence.
3. The highest expert scores* are broadly linked to strategies with most/best evidence.
4. Breeding for methane traits is the most promising but this is not commercially ready, based on available evidence.
5. Farming system will influence most breeding strategies and rate of genetic improvement (e.g., both native, continental and crossbred animals have potential for achieving net zero).
6. Beef and sheep have similar overall themes as above, but the sheep sector appears to have added layers of complexity due to larger variation in systems/breeds.

**The project advisory board and the participants at the final workshop in Autumn 2025 contributed to the ranking of the literature review findings to help prioritise the strategies based on available evidence and current best practice across industry. Strategies circled in green in Table 1 and 2 represent the highest expert ranking.*

Table 1 - Direct and indirect evidence for <u>beef</u> breeding strategies and their contribution to achieving net zero.

Beef: Direct and indirect evidence—achieve net zero 								
Fertility/ Reproductive management	**Efficiency**	**Lifetime performance**	**Longevity**	**Healthy animals**	**Replacements**	Breeds and cross breeding	Farm data and technologies (Enhance/ complement)	Breed for low emissions
Synchronization	**Residual feed intake**	**Age at first calving/Days to calving**	Calving time (spring/autumn)	**Reduce calf mortality (no. of animals weaned)**	Buy in	Breed "changes"	Records	
AI/Fixed time AI	**FCR**	**Ease of calving**	Breeds choice: longer life performance	Breed from dams that produce healthy calves	closed flock/herd	Continental cattle/late maturing beef sires	Breedplan	
ET, IVF	**Average Daily gain**	**Shorter calving interval**	**Productive lifespan**	General herd health management	Farm data	Cross with early maturing/native breeds	AgriWebb	
Bull MOT	**Optimum carcass**	Reduced mature cow size	Breed from animals that live longer		Heifer selection	Match breed to environment	Rumen bolus	
Scrotal circumference	**Reduced days to slaughter**							

Strategies were categorised into direct (**Blue** cells) and indirect (Orange cells) evidence for achieving net zero. Non highlighted cells show strategies that were identified as options for achieving net zero, but with no evidence identified in the literature search. Cells with strategies in **bold** are already available as an EBV or GEBV trait or part of an index. All identified strategies were ranked from 1-5 by a small number of industry experts, based on the perceived potential of achieving net zero. Cells circled in **green** show strategies with the highest expert rating.

Table 2 – Direct and indirect evidence for sheep breeding strategies and their contribution to achieving net zero.

Sheep Direct and indirect evidence—achieve net zero									
Fertility/ Reproductive management	**Efficiency**	**Lifetime performance of ewe**	**Offspring performance**	**Longevity**	**Healthy animals**	Replacements	Breeds and cross breeding	Farm data and technologies	Breed for low emissions
Synchronization	Residual feed intake	**Litter size Mature ewe size**	Lamb weaning weight and rate	Early intro of maiden ewes	**FEC/Saliva IgA/Worm resistance**	Buy in	Prolific breeds (e.g. easy care)	Records	
AI	**Optimum carcass**	**Fecundity (increase lambing rates)**	**8 week scan**	Reduce ewe death rates	Footrot susceptibility	closed flock/herd	Breed for finishing on grass	Breedplan	
Sell barren ewes	**Reduced days to slaughter**	**Ease of lambing**	**Scan weight**		Mastitis	Farm data	Match breed to system/objectives	AgriWebb	
Move lambing date forward		**Lambs lost/reared**	**Birth weight**		Low Breech wrinkle/dag score				
Scrotal circumference		**Maternal ability**	**Lamb survival**						

Strategies were categorised into direct (**Blue** cells) and indirect (Orange cells) evidence for achieving net zero. Non highlighted cells show strategies that were identified as options for achieving net zero, but with no evidence identified in the literature search. Cells with strategies in **bold** are already available as an EBV or GEBV trait or part of an index. All identified strategies were ranked from 1-5 by a small number of industry experts, based on the perceived potential of achieving net zero. Cells circled in **green** show strategies with the highest expert rating.

COST-BENEFIT ANALYSES OF DIFFERENT BREEDING STRATEGIES

We recruited 20 case study farms (beef, sheep and mixed beef and sheep) to provide financial data for a cost-benefit analysis and a carbon footprint audit using the Agrecalc calculator. These data were to be used to model 'what-if' breeding scenarios. Collecting farm data was challenging in the timeframe of the project and overly complex due to the fragmented nature of on-farm data recording. As a result, we only received complete financial datasets for 10 case farms (Wales x 3, England x 2, Northern Ireland x 4 and Scotland x 1) and only five datasets to complete the carbon footprint audit. Therefore, the carbon footprint audit data was not available to publish in this report.

The cost-benefit analyses for the 10 case farms were conducted by SRUC using the ScotFarm model and supplemented with the Farm Business Survey data for Scotland. A total of five breeding strategies identified from the literature review and initial workshops were selected for the analysis as follows:

- Sexed semen
- Estrous synchronization
- Embryo transfer
- Selecting replacements based on EBV
- Conventional breeding of low emitting animals

These strategies were chosen as there is supporting evidence for them in terms of a reduction in GHG emissions, as well as financial data available to input into the model. The model results suggested that some of the strategies, such as adopting animals with a better EBV and improving animal fertility by implementing embryo transfer technology on farms, improved farm profits by up to 40% on average on beef farms, 39% on sheep and 20% on mixed farms. These strategies pose a 'win-win situation' for a majority of these farms; they could save up to £101 by reducing GHG emissions by 1 tonne of CO2e emissions, based on these preliminary results.

Although these results only show a general direction of travel and the varying extent of emission reduction on different farms, the pilot nature of this study and limited data availability makes it difficult to make firm conclusions. A larger and more robust dataset over time would be needed to identify both systems and mitigation measures that benefit farm businesses in the short, medium and long-term.

IMPLICATIONS FOR THE UK BEEF AND SHEEP SECTORS

The preliminary results from this scoping study were presented and discussed at a final industry – academia workshop in September 2025. Based on the discussions amongst stakeholders, the questions asked and the previous findings, the following five thematic conclusions have been drawn.

THERE IS NO "ONE SIZE FITS ALL"

There was a strong consensus that "one size fits all" approaches are ineffective. Breeding strategies must adapt to system type (hill, upland, lowland), environment, and breed characteristics, and that there is a need to match any chosen genetics with farm resources and landscape. Breeding better livestock depends on the farming system; there is no universal or single metric that easily captures its relationship with net zero.

BRIDGING THE GAP - SCIENCE AND DATA WITH CONTEXT AND LIVED EXPERIENCE

There are many great examples of breeding information services (e.g., AHDB) that support genetic improvement in the cattle and sheep sectors, but uptake is low amongst the beef and sheep farming community and echoes similar findings in other countries [7]. Technology use was also seemingly low compared to the adjacent dairy sector. It was discussed how breeding ruminants relies on many traditional farming techniques, such as good animal husbandry, intuition and observation skills, which data cannot replace but does complement. Stakeholders agreed that genetic improvement and overall breeding approach was context-specific and required multiple strategies. Oversimplified models with unrealistic assumptions and poor transparency around data sources did not help with farmers trusting and applying breeding data, which is well known and reported in other studies [8]. To overcome this, there is a need for more co-creation of solutions that value and complement farmer knowledge and on-farm practices with scientific data, such as multi actor methods [9].

NET ZERO BREEDING – COMPLEX TRADEOFFS, EVIDENCE GAPS AND UNINTENDED CONSEQUENCES

Net zero was seen as overly narrow and simplistic term that does not align with the holistic approach to managing a herd/flock most farms take. It was seen as a policy term that disadvantaged some farm systems over others, such as extensive grazing herds compared to indoor herds reliant on bought-in feed, which sometimes failed to account for the role of carbon sequestration and growing feed elsewhere in net zero carbon accounting. Stakeholders consistently highlighted weaknesses in carbon accounting, cost-benefit analyses and single trait measurements or single point breeding strategies that did not account for their cumulative benefits. Genetic improvement is permanent and cumulative and difficult to capture accurately over a one year project timeframe. The lack of empirical evidence behind the relationship between net zero emissions and breeding approaches was

also flagged as a significant limitation to further progress. There were calls for better on-farm data collection and validation of many of the assumptions inherent to the concept of net zero beef and sheep breeding.

THE ECONOMIC REALITY

Economic viability featured heavily in all discussions. Stakeholders viewed profitability as the precondition for sustainability and genetic improvement. The lack of market or policy incentives (compared to some recent Government schemes around animal health in England) and systemic barriers, such as lack of time to make changes on-farm due to pressures like labour shortages, were seen as blocking change in this area. Some stakeholders felt there was a lack of reward from processors and retailers for 'breeding better' livestock (meat yield versus carcass balance). Without a clear economic benefit, environmental goals and net zero emissions were meaningless drivers to change a farm's breeding approach.

KNOWLEDGE EXCHANGE NEEDS A REVAMP

Current systems for communicating and exchanging knowledge around breeding and genetic improvement seems to be lacking the desired effect in the beef and sheep sector. Certain programmes and schemes worked/work well (upland sheep scheme) but others were heavily criticised as too academic or lacking transparency. Trust in data and information was deemed important and is well known to help drive innovation [10]. There was a sense in the last workshop particularly that the sector should focus on implementing existing knowledge around breeding for net zero emissions rather than furthering increasingly distant and exclusive research into innovations for the few, which has also been noted in other work around smart farming [11].

NEXT STEPS

There were many stakeholders who raised questions over a breeding vision for the sector – what is better breeding in the beef and sheep sectors? Some approaches and techniques could be and are perceived to be unethical and threaten the reputation of the beef and sheep sector (e.g., once bred heifers and reduced days to slaughter being seen as slaughtering animals at a younger age, which could be perceived poorly by the public). There was a constant tension between efficiency, longevity, environment and welfare that was not always equally balanced or met, not least poorly communicated to the public risking further reputational damage. What does breeding beef cattle and sheep beyond efficiency and net zero look like?

There appears to be fragmented effort and poor governance around genetic improvement in beef and sheep and an over-emphasis on innovations such as genomically tested animals and reproductive technology as the route to net zero. There was a concern that this was at the expense of getting the basics implemented, such as choosing replacements based on reliable performance records, and also risked unintended consequences, e.g., over

selection of certain traits at expense of animal health and welfare [8,11]. It was unclear which organisations could take a lead on the topic of 'breeding better' for both the beef and sheep sector.

'Breeding better' beef cattle and sheep cannot be done in isolation and cannot be separated from wider environmental, social and economic issues as well as business management and the specific local farming context. Farms are balancing myriad concerns and goals, and to stay profitable and achieve net zero emissions, economic sustainability is a fundamental part. Scientific and empirical evidence is valued and important but must be married with practical farming experience and traditional place-based approaches for there to be widespread trust and uptake of breeding information services like EBV and indexes. The challenge is not lack of knowledge or awareness, but the infamous implementation gap, which is often a product of delivery and wider innovation systems.

This report brings together the numerous discussions, varied perspectives and lived experiences around breeding ruminants to help achieve net zero from a 1-year UK-based scoping study. It has not produced one overall winning strategy or recommendation but rather tries to identify a path forward for the beef and sheep sector that helps to practically reduce emissions from the breeding and farming of ruminants, whilst remaining economically viable.

RECOMMENDATIONS

1. More co-production of recommended strategies for breeding ruminants with meaningful inclusion of varied farmers and aligned industry.
2. Renewed attention on communication approaches and services around utilizing ruminant breeding performance data and uptake of EBV/GEBV in the farming community.
3. Increase equitable representation of breeds in GEBV/Indexes to reflect the diversity of breeds in the UK livestock sector.
4. R&D and Knowledge Exchange budgets should be focused on what we already know impacts net zero emissions, such as collecting empirical evidence for feed efficiency and health, rather than developing traits/technology where there is uncertainty about its impacts on achieving net zero.

BACKGROUND TO STUDY

In 2024, the Agri-Food for Net Zero Network (AFN+) funded fifteen projects to help address the challenge of reaching net zero within the agri-food sectors. The funded projects aimed to address some of the critical challenges we face as we work towards a more sustainable food system. From improving access to healthy, low-emission food, to supporting farmers navigating the path to net zero, as well as working with industry, policymakers and the public sector to better integrate climate policies.

Each project or study received up to £50k to bring together multidisciplinary teams, with academics working alongside food system stakeholders. This scoping study took a devolved nation approach, with participation from industry and academic partners from each of the four nations in recognition that farming practice and reasons behind certain breeding decisions vary across geographies.

OUR APPROACH

This was a participatory project where we were starting from a position of 'non-experts' and were keen to co-produce knowledge with those making the decisions around breeding cattle and sheep day-to-day. We wanted to understand what farmers and advisors were doing currently when breeding ruminants and aiming to improve genetic merit. Critically, we were keen to find out how certain breeding approaches and strategies were contributing to net zero, if at all.

When we started this project, it was clear that there was lots of uncertainty across industry and academia as to the best way to contribute to net zero through the breeding and genetic improvement of ruminants. Not only was net zero seen as a narrow and simplistic policy term, but information was fragmented and sometimes conflicting as to the best way forward, such as around breed choice, growth rates and GHG emissions. Data sources to support breeding decisions, such as EBVs are not widely used or trusted across the beef and sheep sectors and/or are not evenly applied to the multitude of farming systems across the sector.

Therefore, we aimed to identify which specific breeding strategies and ways to improve genetic value had the most merit when it came to contributing to net zero, whilst still being practical, cost-effective and good for animal health and welfare. We reviewed what was in the published literature by appraising the level of evidence around

ways to breed ruminants for net zero emissions, and at the same time, brought in industry expertise and farming knowledge to understand the feasibility and practicality of recommended breeding strategies.

Using interactive workshops, we engaged with 36 stakeholders (22 farmers) from across Scotland, Wales, Northern Ireland and England at the start of the study to understand what current breeding strategies were being used, why, and some of the challenges with breeding for net zero. We worked collaboratively to make sense of an area that has a lot of potential to help farmers be green, whilst keeping the farm business profitable. We collected data from a diverse set of case farms from across the UK to calculate the potential impact of different breeding strategies on a farm's carbon footprint and the cost-benefit of any change. Essentially a series of 'what if scenarios' were derived to help us examine the differences in approaches and their outcomes. We also had an advisory board consisting of the following organisations that fed into the work and helped improve its applicability and ground it in current work and developments.

Advisory board members

-National Sheep Association

-Farming Connect

-Scotland's Rural College

-Innovis

-The UK Agri-Tech Centre

-Agriculture and Horticulture Development Board

-ADAS

-Ulster Wildlife

ACKNOWLEDGEMENTS

We would like to thank all the farmers that took part in this study by participating in workshops and by sharing their data so openly with us. We are also grateful to the farming industry members that took their time to participate in workshops and in the advisory board. Finally, we would like to thank the funders for making this new collaboration between industry and academia possible and having the vision to support research into breeding livestock for net zero.

RELEVANT SOURCES

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