# LIVESTOCK GENETIC IMPROVEMENT TO REDUCE GHG EMISSIONS

**The use of genetic technologies allows desired traits to be chosen at the point of breeding, giving a more assured outcome at an earlier stage rather than waiting for the offspring to mature before the desired traits can be identified. Livestock genetic improvement offers a promising pathway to reduce GHG emissions and can be achieved through:**

## 1. Improving Feed Conversion Efficiency (FCE)

Genetic improvement can lead to increased milk or meat production (output) with the same amount of feed or land (input), leading to more efficient animals emitting less methane per unit of product. This can be achieved by selecting for efficiency traits and considering Estimated Breeding Values (EBVs) such as:

- **Lamb growth rate:** Faster growing lambs often have better feed efficiency (though not always). Used as a proxy trait in genetic evaluations where direct intake data is unavailable.
- **Muscle and Fat depth:** Sheep that deposit more lean tissue efficiently are often more feed-efficient. Muscle depth is also positively associated with growth and carcass efficiency.

## 2. Improving Lifetime Productivity and Reproductive Efficiency

Genetic selection for longevity improves lifetime efficiency. Animals that live longer, produce more milk or offspring, and stay healthier over their lifespan emit fewer GHG emissions per unit of product.

**Benefits of selecting for fertility and prolificacy**

↑ More lambs per ewe per year = Higher output per ewe.
↓ Reduced replacement rate = Lowering rearing costs and less resource use.
↑ Better lamb survival = Increased output.
↓ Lower mortality = Less wasted emissions.
↑ More consistent lambing patterns= Shorter lambing interval= Easier labour management
↓ Lower emissions intensity (GHG per kg lamb produced) = Lowering environmental footprint
↑ Accelerated genetic gain

In order to achieve genetic selection for fertility and prolificacy, the use of Estimated Breeding Values (EBVs) from genetic evaluation programs such as Signet within the sheep industry, allowing for traits to be selected for, including:

- **Litter Size:** Indicates the number of lambs born per ewe, where heritability is moderate.
- **Maternal Ability:** Assesses the ewe's ability to rear lambs effectively.
- **Mature Size:** Estimates the adult size of the ewe.

## 3. Improving Animal Health and Longevity

Sick animals have lower productivity but still emit GHG emissions. Breeding for disease resistance, including mastitis, parasitic infections, respiratory diseases and more, improves overall livestock productivity and longevity.

## 4. Selection for Low-Methane Emitting Animals

Methane is a natural byproduct of the digestive process of ruminant animals, where microbes in the rumen ferment feed and produce methane as a waste product (known as enteric methane production). Genetic selection for traits that reduce methane emissions per unit of feed intake, such as selecting animals with lower methane production or improved feed conversion efficiency, can significantly reduce overall methane emissions from livestock.

Methane emissions vary between individual animals, even under the same diet. Recent advances in methane phenotyping and genomic selection allow breeders to identify and select animals that emit less methane per unit of feed intake.

### Breeding Sheep With Reduced Methane Emissions

**Rumen morphology and microbiome analysis**

Ruminants like sheep and cattle have diverse microbes in their stomachs that ferment feed to digest it. Enteric methane is a by-product of this process that is released via belches, contributing to 30% of methane emissions into the atmosphere each day. Manipulation of these microbes and subsequently breeding treated animals can reduce methane emissions in the next generation.

**Measuring Methane emissions**

One promising technology in this space are Portable Accumulation Chambers (PACs). Sheep are individually enclosed in an aluminium chamber where methane and carbon emissions along with live weight are measured. The process takes 50 minutes and can measure animals straight from pasture. Study shows results are moderately repeatable across diets and feeding levels as well. Other breeding traits (e.g. growth rate, maternal traits, carcass quality) can also be monitored in the pedigree-recorded flocks where these measurements are being taken, with the aim to enable a genetic selection programme that optimizes all important breeding goals simultaneously.

This comprehensive set of information will enable understanding of the genetic control of these characteristics and DNA sampling will allow relationships with the underlying genome of the sheep to be investigated. This will result in tools to compare the breeding value of sheep in the flocks, identifying breeding stock that will contribute to improving farm carbon footprint.

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