Hybu Cig Cymru
Meat Promotion Wales

Perfecting the Welsh Way

A practical guide to sustainable sheep and beef farming

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Contents

Introduction

Agriculture is on the cusp of radical change worldwide, with unprecedented levels of opportunities and potential challenges for the Welsh red meat sector. This needs to be seen as the start of a new chapter, where farmers are at the heart of the solutions for a sustainable red meat sector, international food security and improving global health.

Wales, through the Welsh Government, has committed to achieve net zero emissions by 2050 and this should be met through actions within Wales rather than international offsetting. To achieve this target every industry and sector in Wales will need to seek, deliver and demonstrate improvements, with agriculture and red meat production being no exception. The Welsh Government target is aligned with the overall UK Government target. This net zero ambition, while challenging, can be achieved on Welsh beef and sheep farms through gains in efficiency and productivity combined with an increase in the amount of carbon that is sequestered through grasslands, hedgerows and other fringe vegetation. This ability to offset emissions is almost unique to the agricultural sector.

There is also an opportunity to increase the amount of renewable energy produced on Welsh farms. This important process is categorised as a separate sector to agriculture when calculating greenhouse gas emissions within the national inventory, however it should be noted that one in five farms across Wales are already generating renewable energy on their land.

HCC published The Welsh Way: Towards Global Leadership in Sustainable Lamb and Beef Production in December 2020. This document highlights that livestock agriculture is in a strong position to contribute to a global effort to mitigate climate change as it can cut greenhouse gas emissions and reduce waste through changes on farm while contributing positively to soil health and biodiversity.

The Inter-governmental Panel on Climate Change (IPCC) has warned that the climate change in coming decades will see enormous challenges posed to food production, and the societies which depend on farming and the land. It also emphasised that different solutions were needed in different global regions, and that attention needed to be paid to food security as well as emissions.

In many ways, livestock agriculture in Wales is an excellent example of the right kind of farming in the right place. Wales has a temperate climate and a topography which leads to an abundance of grass and water; the rugged terrain also makes it less suitable for other kinds of farming. Research highlighted within The Welsh Way showed that beef and sheep production in Wales had a significantly lower carbon footprint than previously published global figures.

The major IPCC report of 2019, Climate Change and Land, argues that taking land out of food production would be unwise in terms of global food security, while major changes are needed to ensure that humanity uses land to produce food in ways which can withstand climate impacts and avoid further negative consequences such as desertification and deforestation. It stresses that a global perspective must be born in mind, but that different policies are needed in different regions of the world, taking into account issues of economic and cultural sustainability.

As this document will show, there is variation in standards and practice within Wales, and a number of practical measures that can be adapted by farm businesses to increase their efficiency and carbon sequestration potential, and reduce their emissions.

Sustainable production is more than just assessing the total amount of greenhouse gases associated with every kilogram of meat produced. It encompasses the environment, biodiversity, resource use, culture and people. All these aspects of sustainability are crucial to the fabric of the Welsh red meat sector and need to be looked at in the whole. However, given the challenging Government and industry targets on reducing emissions from agriculture, this document has been produced to support the red meat sector to identify the key actions that should be prioritised over the coming years.

Greenhouse emissions and livestock agriculture

The three main gases which impact on global warming are carbon dioxide, methane and nitrous oxide. In the atmosphere, these absorb energy and slow the rate at which energy escapes into the outer atmosphere, thereby acting as a blanket around the earth - thus causing the average temperature of the earth to increase.

Carbon Dioxide (CO_2)

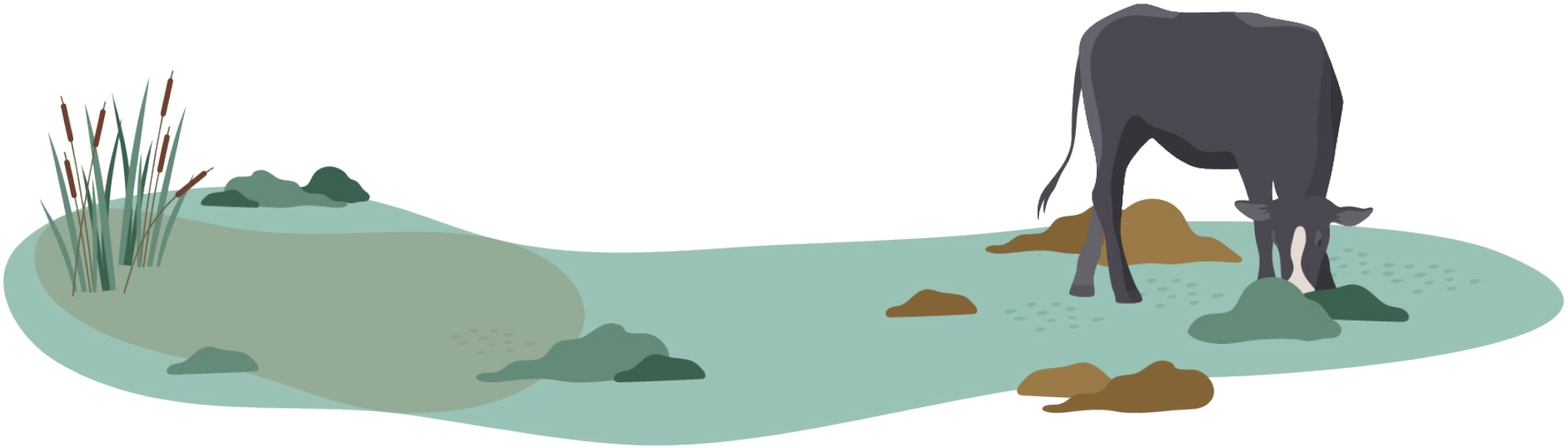
Carbon Dioxide (CO_2) is predominantly associated with burning fossil fuels (such as petrol, diesel and coal), For agriculture, the main source is the production of fertiliser known as artificial nitrogen as it is a very energy-intensive process. Fuel for farm vehicles is also a source of CO_2 emissions.

The areas to focus on to reduce carbon dioxide emissions for the beef and sheep sector are nitrogen fertiliser use and fuel for agricultural vehicles.

Methane (CH_4)

Methane (CH_4) is produced from the digestive process of ruminant animals, known as enteric fermentation, and manures. Methane production from cattle and sheep is linked to their total feed intake. There are a few fundamental basics that can impact on the amount of methane produced per animal, for example the more days they spend on the farm. Larger mature-sized animals generally produce more methane.

The areas to focus on to reduce methane emissions for the beef and sheep sector are improved livestock fertility, liveweight gain and efficiency. These are linked to genetics, health and welfare and nutrition.



Nitrous oxide (N_2O)

Nitrous oxide (N_2O) is produced from the breakdown of nitrogen in manures and soils. Feeding excess protein will increase the risk of nitrous oxide emissions from manures. In soils, the release of nitrous oxide generally occurs in wetter soils, so drainage and good soil structure is important.

The areas to focus on to reduce nitrous oxide emissions for the beef and sheep sector are to ensure the animal or plant uses nitrogen as efficiently as possible. For example, balanced rations to reduce excess protein passing through; or application of slurries, manures and fertilisers at appropriate times when the plant is growing and soil conditions allow so that the nitrogen is utilised by the grass or plant rather than it being lost.

According to the National Atmospheric Emissions Inventory (NAEI), around 90% of the greenhouse gas emissions associated with beef and lamb production are composed of methane and nitrous oxide.

Greenhouse gases have different strengths and life-span in the atmosphere. Nitrous oxide is nearly three hundred times more potent at trapping heat than carbon dioxide, while methane is 25 times more potent than carbon dioxide.

In stable populations of livestock or wildlife, methane can be part of a neutral natural cycle. It is a short-lived gas which breaks down in the atmosphere over 10-12 years, while any carbon dioxide or nitrous oxide release will still be having an effect after 100 years. This has big consequences for emission calculations.

A new, potentially more accurate calculation method (called GWP*) has been developed, which is now being reflected in global policy frameworks. According to the IPCC Sixth Assessment Report of 2021, previous methods of calculating the impact of methane on climate change may have overstated the impact of stable methane sources (such as herds and flocks which are numerically stable) by a factor of three or four, while underestimating the effect of new sources of methane.

The need to change

With climate change being a real threat to the world's population it is imperative that all sectors and industries take responsibility to question what they do and make changes to reduce emissions and enhance the environment. Although agriculture is already adapting techniques and lowering emissions there is a need to seek continuous improvements.

Many actions needed to improve environmental sustainability have the added advantage of improving the productivity and profitability of Welsh beef and sheep farm businesses.

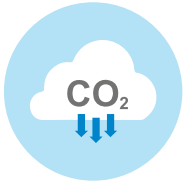
Although many of the measures needed are not new, their application within the diverse range of livestock systems in Wales are all within the capabilities of the industry and must now be prioritised across all beef and sheep farming systems and should also take into account the increasing contribution of beef produced from the dairy sector.

These activities cannot not be taken in isolation. Progress must be made in all areas within the capabilities of the land and the livestock in each farm. Many of these activities are inter-related. Together, these can have a significant impact on the economic and environmental performance of beef and sheep enterprises. It is important that the progress being made and, in some cases, already made, is quantified and documented so that the positive contribution of the sector can be clearly seen.

A sustainable and decarbonising Welsh red meat industry can be achieved if efforts are made to optimise:

Productivity - including genetic improvement, breeding capacity, animal health and welfare, feed efficiency and selection for slaughter.

Grassland management - protecting soils and optimising production from grassland.



Carbon capture and sequestration - including conservation grazing, woodland management, hedges and provision of shelter belts as well as areas of peatland.

All of these activities complement each other and together can make a significant difference on every farm in Wales.

Some of the measures may not be as effective or applicable to all farms. An example of this could be the cost, effort and impracticality associated with cultivating and reseeding hill pasture as opposed to lowland ground, where the economic and environmental costs may be greater than the potential returns. Due to this, priority should be given to those measures which are both effective and practical for each farm.

Renewable energy and reducing the impact on natural resources.

Resource efficiency – water usage, slurry and manure management; and purchased input usage.

Current performance

Measuring the greenhouse gases from agriculture is more complicated than for most other sectors. Whilst others measure the carbon dioxide emitted through burning fossil fuel, in agriculture emissions relate to natural biological processes, which vary greatly depending on a wide range of environmental and production factors.

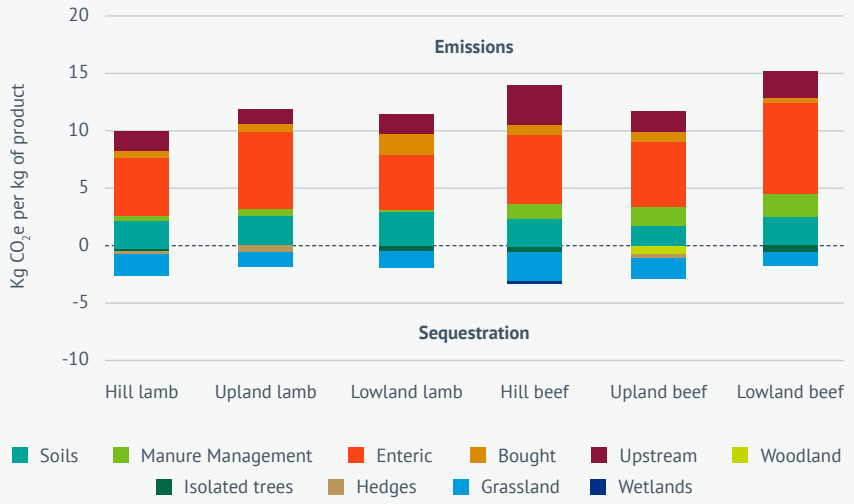
As part of The Welsh Way, HCC analysed the carbon footprint of beef and sheep farms in Wales. This work was undertaken by Bangor University, in collaboration with the University of Limerick, and analysed detailed data from a sample of 20 Welsh family farms. The farms were a cross-section of agricultural businesses, including those in hill, upland and lowland areas, and those rearing beef cattle, sheep or both.

The research found that the carbon footprints of these Welsh farms are amongst the lowest reported for countries producing beef and lamb. However, importantly the results also highlight areas of potential improvement.

Comparing the figures from the Bangor study to global values is difficult given that data obtained from different studies have different assumptions and methodologies. However, the results do indicate that Welsh lamb and beef producers have the potential to be - and are - some of the most sustainable production systems globally.

The Bangor University carbon footprinting work also highlighted the vital role that carbon sequestration has in reducing the overall emissions associated with livestock production - which is detailed further in the section on carbon capture.

Average carbon footprints for the study farms, broken down by greenhouse gas sources



Source: HCC commissioned research from Bangor University, in collaboration with the University of Limerick.

Figure 01

There are many ways in which Welsh farms can reduce their carbon footprint, which will also improve efficiency and productivity, and these will be explored more in this document. Achieving lower emission systems through productivity gains should be the focus for the industry and those that support it and will ensure the overall impact of Welsh livestock production is reduced while also maintaining production, economic activity and increasing environmental, economic and cultural sustainability.

Productivity – a target for all businesses

Improving productivity helps increase the profitability and sustainability of enterprises whilst at the same time reducing greenhouse gas emissions. But for this to be effective it has to be driven through improved efficiency rather than by higher inputs or increasing livestock numbers.

Optimising productivity of Welsh beef and sheep enterprises can be achieved by ensuring that:

- Livestock are healthy and that preventable health issues or diseases do not result in production losses or poor performance.
- Fertility and breeding capacity of herds and flocks is maximised, thereby producing viable calves and lambs in an efficient breeding cycle.
- The genetic make-up of herds and flocks are improved to breed efficiently, enhance growth, optimise carcase conformation, optimise feed efficiency and maximise resistance to disease.
- Livestock receive the correct level of nutrition at each stage of production allowing them to reach their full performance potential.
- Livestock are selected for slaughter when they reach the correct level of finish. This will help to reduce days on farm, reduce unnecessary input costs and will maximise returns from meeting market requirements.

Using key performance indicators (KPIs) to monitor the performance of herds and flocks plays an important role in helping to develop sustainable beef and sheep businesses - not only in terms of building a resilient business but also to demonstrate the environmental credentials of Welsh beef and lamb production.

To achieve greater efficiency and productivity it's important to consider current performance and also where resource would be most efficiently utilised. For example, the chart opposite shows the emissions that were associated with sheep system on the hill farms that were carbon audited within the Welsh Way.

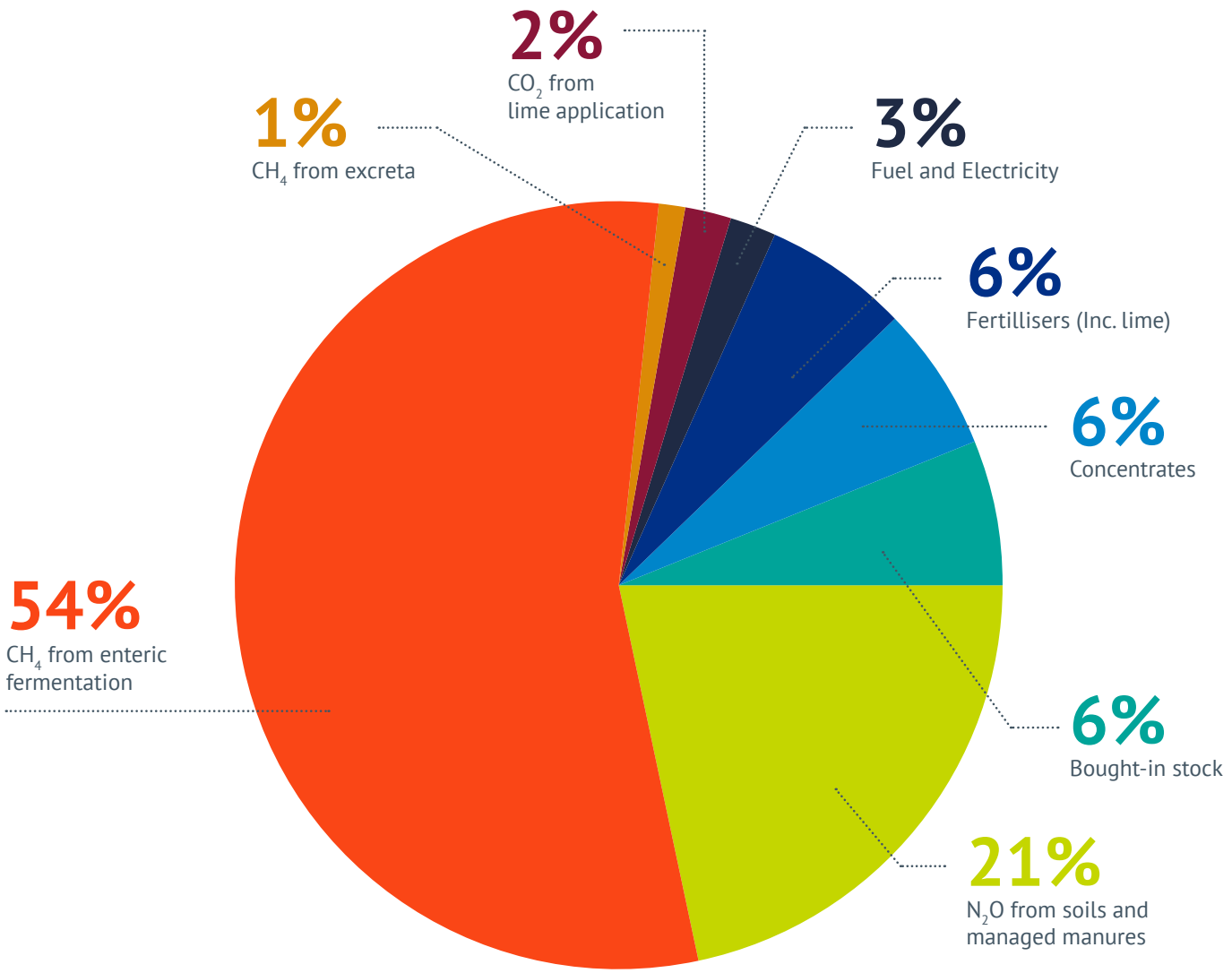
It can be clearly seen that some emissions associated with the production system - such as enteric fermentation (methane) and N_2O from soils - have a greater importance to overall emissions than others, such as fuel and electricity. It would therefore seem sensible that the concentration of resource and effort should be on the activities that would see the largest reduction in emissions, while understanding that having a holistic approach to the whole system and the interdependencies that exist within it is important.

To achieve this improved productivity and drive decarbonisation, this document will outline a number of on-farm focus areas:

- **Livestock**
- **Grassland/cropping (including fertiliser usage)**
- **Feed**
- **Manure management**
- **Fuel and energy**
- **Carbon balance (sequestration)**

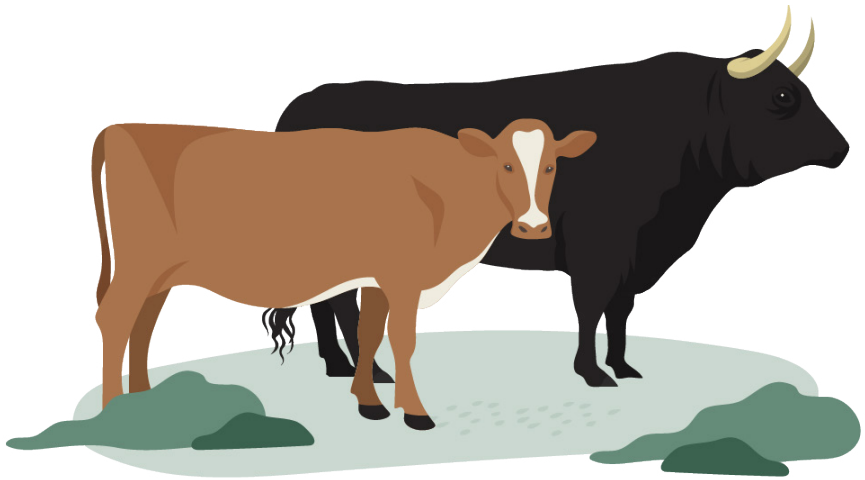
Figure 02: Sources of emissions on Welsh hill sheep farms

The chart is based on the GWP100 measurement which was current at the time of the study and used within national inventories. It should be noted that the move to GWP* will entail a different method of calculating methane's impact which would likely result in a considerable decrease in its contribution to overall greenhouse gases from beef and lamb production (assuming a stable livestock population).



Source: Carbon audits conducted for HCC, The Welsh Way

06 | **Livestock**



Key areas of focus for ensuring a productive livestock system include animal health and welfare, breeding capacity, genetic improvement and correct nutrition.

Optimising animal health and welfare is one of the simplest and most effective ways to maximise the efficiency and the outputs from Welsh flocks and herds, irrespective of the farming system.

Methane production is linked to feed intake so the longer a store or slaughter animal is on farm the higher its potential methane production. Some of the factors that can impact on growth rates are linked to health and welfare. These can include parasite burden, lameness or diseases (such as Johnes and BVD) and abortion. Animals performing below their optimum due to health or welfare issues will invariably add cost and also emissions.

Data and records are essential to identify problems (e.g. timings of sales, growth rates, number of lame animals treated or mortality rates). Following the collation of these records, the next step is to work with a vet to develop an active health plan bespoke to the farm and animal health concerns. Regular engagement and communication should be sought with the vet during the year to review the plan as each season will provide different challenges.

Breeding animals (cows and ewes) contribute more greenhouse gases per head than smaller younger animals (calves and lambs). Optimised fertility of breeding livestock is therefore critical to reducing emissions, as it means that more kilograms of calves or lambs are weaned per mated female. A measure of this could be to reduce the number of unproductive livestock on the farm, e.g. barren or empty animals being retained.

Longevity of breeding livestock is also important as it means that the emissions generated during the rearing phase can be spread over more kilograms of output over her reproductive lifetime. Examples of how the productive lifetime of female animals can be optimised include calving heifers at 24 months and breeding from ewe lambs. As with health and welfare, a focus on breeding capacity will increase the profitability of the farm.

Reducing the calving interval is of particular relevance to suckler cow systems. An extended calving interval means that the greenhouse gas burden of unproductive adult cows has to be carried by other animals. Given the proportionately higher weight of adult cows, they can account for a significant proportion of the methane emissions. A long calving period may also lead to further inefficiencies at later stages of production, such as issues around optimal feeding for animals at different growth stages.

Rhodri and Claire **Jones**

Animal health and productivity

Rhodri and Claire Jones' hill farming business at Brynllech, near Bala, includes 700 ewes and 38 suckler beef cows. The Jones' have been part of the Stoc+ project since 2019; Claire, a vet, is also a Stoc+ Vet Ambassador. Stoc+ is one element of HCC's Red Meat Development Programme.

What we're doing

"Farm health planning is absolutely key to the future of farming. Working and communicating with the farm vet, to identify problems and weaknesses and manage and minimise these areas, allows us as farmers to improve our farm and stock efficiency, profitability, sustainability and welfare."

Farming system

Cattle and sheep are farmed on land that rises from 900 feet at the farmyard to 1,650 feet at the top of Mynydd Brynllech, an enclosed mountain on the farm.

Rhodri and Claire utilise breeds that are suited to the farms hill location - they have a herd of Welsh Black suckler cows and a flock of north-type Welsh Mountain sheep.

There is a small flock of pedigree MV-accredited Suffolk ewes and the pedigree Brynllech herd was established in 1998.

Cattle are winter housed and the majority calve in the spring to enable outdoor calving to minimise inputs and support animal health.

Block calving relies on good fertility therefore regular ultrasound checks within three months of breeding are used to detect pregnancies early and to pick up any problems, either with the cows or the bull.

Post-calving checks are carried out on the cows six weeks after calving, before the bull is introduced, to check that the cattle are clean and cycling again.

Early detection of pregnancy also means calving dates can be predicted much more accurately, which aids cow management as they progress through their pregnancy.

Ewes lamb outdoors in April.

Lamb performance is monitored and evaluated through regular weighing to estimate days to finishing and to assess the effectiveness of management practices.

The lambs are regularly FEC checked every four to six weeks through the summer grazing season and only treated if this shows a need.

Farm Facts

- 263ha farmed
- Herd calves over eight weeks, from the beginning of May
- Cattle finished at 24 months, at 600kg

Genetic improvement generates efficiencies of production and produces livestock that are better suited to meet market requirements. Its impact is also cumulative over time bringing long-term benefits. Genetic improvements have been shown to bring environmental benefits in terms of reduced emissions.

Breeding livestock for reduced emissions is not just about growth rates, it is also about maternal traits to enhance breeding capacity. Estimated Breeding Values (EBVs) are crucial to evaluate these traits as they cannot be visually assessed from the bull or ram. For example, to support improved cow fertility, bulls can be selected based on birth weight, gestation length and direct calving ease EBVs. Bulls being used to breed heifers can be selected on calving interval, days to calving, gestation length, birth weight, calving ease daughters, age at first calving and scrotal circumference EBVs to improve their fertility performance.

Genetic improvement offers beef and sheep producers the ability to increase growth rates, improve conformation, improve maternal traits and reduce emissions without having to make significant changes to their system.

Extension of recording and uptake of genetic improvement across hill and upland beef herds and flocks should become an integral part of future hill farming. This will allow considerable progress to be made in these areas while maintaining the environmental benefits of grazing these areas.

For hill flocks, optimising litter size based on the farm system, increased ewe longevity and increasing carcase weight should lead to a reduction in methane emissions per kilogram of food produced. If lamb growth is improved without increasing ewe weight, methane emissions are significantly reduced.

Irwel **Jones**

"Performance recording in the hills has a major trickle-down effect on the whole sheep industry."

Hill genetics

Irwel Jones and family have 950 Tregaron-type Welsh ewes and 40 Continental-cross suckler cows on his hill farm in the Upper Cothi Valley. Irwel is part of HCC's Hill Ram Scheme - an element of the Red Meat Development Programme.

What we're doing

"By utilising our farm's resources we are producing breeding stock that are suited to their hill environment and lambs that meet target specification. It has allowed us to create an efficient hill ewe."

Farming system

Flock output in the commercially-managed flock is being advanced by using the latest genetics technology.

Being involved in the Hill Ram Scheme has enabled Irwel to DNA test sires and dams to assign parentage and record progeny traits in his hill flock, to produce recorded Welsh Mountain rams. This allows for minimum intervention at lambing.

A DNA sample is taken from lambs when they are tagged at four weeks old.

Eight-week weights and weaning weights are linked back to the lamb and ultimately their sire and dam, allowing selection decisions to be based on actual data.

Tups are bred to produce earlier finishing lambs and flock replacements with high maternal ability.

Performance recording has resulted in improved carcass weights and grades - lambs average 18kg deadweight at carcase grade R3L.

Irwel keeps a close eye on parasite burdens through FEC testing and uses daily liveweight gain data to inform decision making on dosing lambs at the correct time.

Ten per cent of the farm is reseeded annually. Four hectares of swedes are grown as feed for 280 twin-bearing ewes in the two months leading up to lambing in the first week of March.

The business has invested in a 7KW hydroelectric system to generate energy for home use and as a source of income too since additional energy is sold to the National Grid.

Sustainability

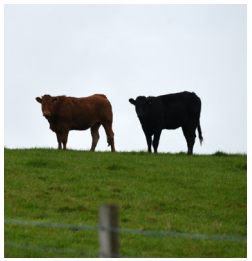
As Irwel plans towards a future of changing direct support, he has placed strong emphasis on reducing production costs and maximising output.

"Concentrating on improving the flock genetics is allowing us to produce more meat from more efficient sheep year on year with no change to our management and no extra feed. We see this as crucial as we seek to optimise the flock's performance.

"Our hydro scheme is an important additional source of income for a hill farm and also has the potential to provide benefits for the environment, climate change and helps the wider public and future generations."

Farm Facts

- 263-hectare hill farm
- Land rising from 650 feet to 1,250
- Mountain grazing rights for hefted flock
- Outdoor lambing in March and April



Ensuring the correct nutrition is another essential aspect of productive beef and sheep systems. This leads to higher performance, such as more calves weaned per cow or lambs sold per ewe, and reduced finishing times. It plays an important role in achieving both economic and environmental sustainability on Welsh beef and sheep farms. It will reduce concentrate feed requirements, lower feed costs and increase growth rates, improve conception rates and improve neo-natal performance.

Although lifetime productivity can be driven by genetics, livestock must be appropriately fed to express that genetic potential. This includes balancing forage and any supplements to meet their needs. This must take account of the type of livestock (cattle or sheep), and on stage the animal is in its lifetime cycle (i.e. pregnancy, lactation, growing or finishing).

For sheep, mature size estimated breeding values (EBVs) are being developed, as heavier animals will have higher feed requirements. For cattle, feed efficiency EBVs are being developed through scientific studies and are already available for some breeds, e.g. Stabiliser cattle. When evaluating performance, it is worth considering the nutritional requirements, and therefore the maintenance cost, of the animal. Larger mature sized animals should produce more output (kilograms) than smaller animals within the herd or flock.

Body Condition Scoring (BCS) is the easiest way to assess whether the diet is providing livestock with the required energy to perform. It is an under-utilised tool which can bring considerable benefit when managing breeding livestock, e.g. cows or ewes post-weaning, or when getting cows or ewes back into condition for mating. Monitoring and managing BCS will also enable the livestock to be in good health so when the immune system is challenged the animal is able to respond to this quicker and with the correct immune response and production losses are kept to a minimum.

Rhys **Edwards**

Smart use of genetics

Rhys Edwards has a data-driven approach to genetic improvement in the sheep enterprise he runs with his parents, Russell and Eira, at Hendre Ifan Goch, Bridgend. The farm is part of HCC support genetic improvement research project - RamCompare.

What we're doing

"Genetics plays an important role in how we keep our farm moving forward as a sustainable business. Nine years ago we were selling 80% of lambs as stores, we are now finishing over 98% within specification off grass alone."

Farming system

A flock of 600 ewes and 130 ewe lambs is run on a rotational grazing system; 400 Texel cross Mules are bred to terminal sires and 200 Welsh Mules used to breed replacements.

Flock breeding decisions are made by analysing a wealth of data recorded on the farm as part of the RamCompare project.

Using rams with high genetics for growth rate has closed the gap in days to slaughter between progeny groups by as much as 61 days.

Average birth weight has increased by 0.65kg since 2017, to 5kg in 2021.

The entire flock is EID recorded and the data and information generated used to improve management.

Growth rates and deadweights are analysed against sire and dam performance.

Capturing and using flock and grass data has lifted output per hectare (ha) from 284kg to 414kg, while at the same time keeping costs low.

Constant monitoring of farm outputs flags up areas for improvement, whether that's under-performing ewes, unproductive fields or groups of lambs with lower carcase weights.

A 5.5kW hydro generator produces an average of 27,000 kilowatt hours (kWh) annually. The farm is blessed with rain - an average of two metres annually - which provides ample water. The electric generated from the hydro power supplies the farmhouse and farm buildings.

The initial investment was £16,000 with a projected payback period of five years but it outperformed that prediction and paid for itself within three years.

Sustainability

"The RamCompare work has allowed us to explore opportunities for improvements in our flocks performance through utilising superior genetics. More of our carcases are achieving market specification which means a price premium.

"By using genetics in a smart way we are reducing the days to finishing, we can get lambs off the farm and sold quicker. This supports grass availability for the ewes over the autumn and winter."

Farm Facts

- 101ha farmed, incorporating a 87ha grazing platform
- Land rising from 600 feet to 1300 feet
- Indoor lambing from 10 March; more than 90% lamb in the first cycle

07 | **Grassland and Cropping**

Grassland is the most important livestock feed source in Wales and one of the most precious natural resources. It provides a cost-effective, natural, high quality feed for cattle and sheep. Improvements to the quality, quantity and utilisation of grass and forage produced for beef and lamb production will help to ensure that grass, clover and forage have the best possible nutritional value. While this has clear productivity gains, research by HCC as part of the Red Meat Development Programme has shown that this will also mean that the final meat product will also have higher nutritional value to the consumer. Pasture and grazing management is key to making the most effective use of grassland and forage.

Soil is the starting point for optimising grassland production and quality and is therefore critical to all livestock production. It is a vital and sustaining farm resource and ensuring the health of soils provides a legacy for future generations. Poor soil health or management practices which deplete soil resources will undermine all other efforts to build a sustainable beef or sheep enterprise.

Knowing the texture, structure, condition and nutrient status of the soils on Welsh beef and sheep farms is crucial. It allows producers to make the most from their soil, and improved understanding of soil management can make farm businesses more profitable and sustainable. Soil health is dependent on previous management (e.g. cultivations, grazing system, lime application and fertiliser use) and soil characteristics (e.g. texture, type and acidity [pH]). These all have implications for soil structure, nutrient levels and biology.

Land use and management choices can have an important role in determining the amount of carbon released into the atmosphere or stored in the soil. Very simply, the aim should be to reduce soil disturbance (e.g. reduce frequency of ploughing or any cultivations) and to increase plant and root diversity to protect the carbon already stored in the soil and encourage more to be sequestered. Wales has a high proportion of permanent pastures that are rarely cultivated, so the focus should be to protect the soil to maintain the existing carbon stores and to use grazing systems that capture more carbon in the soil.

Tillage before re-seeding is likely to give rise to carbon losses from soils as some of the accumulated carbon will be turned over. From a carbon perspective, it is better to reduce the frequency of re-seeding by managing older leys so that they remain productive thus reducing the need to re-seed as often. However, the rate of sequestration is likely to be increased following re-seeding due to higher yield from a new ley, which recovers some of the carbon lost, until the soil again reaches equilibrium.

For a re-seed, minimum tillage approaches such as direct drilling or broadcasting is preferred as they reduce soil carbon losses and the risk of soil erosion. These approaches are only effective however if soil is not compacted and the competition from the existing sward is properly managed. It is important to correct any soil indexes and acidity (pH) ahead of a re-seed and to explore why the level of sown species in the sward has declined.

Wales has a relatively high prevalence of permanent pastures and nutrient inputs are not significantly high compared to many other types of farming across the world, therefore grass-fed livestock systems play an important role in minimising carbon emissions from production. Cattle and sheep play an important role in land management. This is particularly evident in mountain, hill and upland environments which are unsuitable for most other types of farming. Grazing management can increase biodiversity of flora and fauna and reduce the ingress of shrub vegetation in non-intensive farming systems.

Growing and grazing diverse multi-species swards is another way to maximise the carbon stored and sequestered in soils. Multi species swards can be new leys with grasses, clovers and herbs sown in or be long- term permanent pasture where many secondary grass and broadleaved species, including legumes, have colonised. These are often adapted to have plants that survive and thrive in a range of weather conditions to help resilience and stock performance. They will have a range of rooting structures, which allows them to access nutrients throughout the soil profile and when the roots die back they help build soil organic and create drainage channels. Managing the grazing of swards (by avoiding over-grazing in the winter and under-grazing in the spring and summer) will help to encourage a range of productive species in the sward.

Rotational and tall grass grazing systems are both practised on farms with the aim of increasing soil carbon. The key with these grazing systems is that they prevent over-grazing and allow the plant recovery time, which is important as it allows sugars to build up in the roots. These sugars allow the plants to recover once they have been grazed and are also an important to maintain and improve the soil biology, which helps to make the system healthier.

Using legumes (plants that increase nitrogen in soils naturally, such as clover) can provide a valuable source of high protein, home-grown fodder, and reduce the need for bought-in fertiliser. When re-seeding, grasses of a high water-soluble carbohydrate (WSC) concentration ('high-sugar grasses') have been shown to reduce nitrous oxide emissions from pasture systems through reduced animal excretion of nitrogen compared to animals feeding on conventional grasses.

Prioritising the management of clover-rich swards can reduce the reliance on nitrogen fertiliser and purchased protein feed. To maximise the benefit, careful seed mixture selection and appropriate management is needed. White clover and grass leys are more suited to all year grazing and silage (depending on leaf size). Red clover leys tend to be shorter term, more specialist crops, ideal for high quality silage and for finishing livestock. Good grassland management planning can ensure that these leys contribute significantly to both the livestock diet and soil health. Both clovers will improve soil structure and health.

The use of nitrogen fertiliser can lead to the production of high-quality grass and forage, which can be more cost-effective than purchasing feeds. However, it can be a significant contributor to a farm's carbon footprint. Research within The Welsh Way highlighted that this was the fourth highest source of emissions in Welsh agriculture and equated to just over 10 per cent of the total. Optimising – and where appropriate, lowering - the use and application of any purchased fertiliser should be seen as a key aim within grassland management. The use of new technologies and techniques such as GPS and calibration trays needs to become more widespread. Combined with fully understanding the soil structure and status, this would help make the most of any fertiliser input.

It is important to select a production system that meets the farm's resources, as this will help to reduce inputs (feed, fertiliser and chemicals) while maintaining or increasing production. The most profitable systems are those that match production with grass growth, and these systems will invariably have fewer emissions.

Aled **Picton Evans**

Grassland management

Aled Picton Evans produces beef and lamb on a grass-based system near Whitland, Carmarthenshire. The farm has a 52 hectare (ha) Technograzing platform for cattle and sheep. Aled and brother Iwan are the Farmers' Weekly beef farmers of the year for 2021. The farm is part of a grassland research project HCC and other organisations are funding - GrassCheckGB.

What we're doing

"Our ultimate aim with both livestock systems is to get as much output from grazed grass as we possibly can, to ensure the quality of production while minimising costs.

"It is widely accepted that grass is the cheapest feed available for livestock farmers in Wales so it makes perfect sense to maximise its contribution to our animals' diet."

Farming system

Lamb is produced from a flock of 700 New Zealand Romney and Highlander ewes while around 325 dairy beef cattle are finished every year.

Calves are bought from local dairy farms when they are 1-2 weeks old. After weaning their diet is grass and forage.

The goal is to rear and finish cattle at 320kg at 20-24 months.

The system is relatively simple - to grow as much grass as possible and turn that grass into kilos of liveweight gain.

But it is not only about growing high volumes of grass, growing good quality grass and ensuring maximum utilisation and minimise wastage is key.

To achieve this, Aled has focussed on grassland management, targeting high entry covers of 3,000kg DM/ha because the more leaf there is the greater the energy available to the grass plant.

This promotes root depth too, and Aled has even seen water infiltration rates increase by 75% since he adopted this approach to grazing.

For GrassCheckGB weekly measurements with a rising plate meter are taken during the grazing season. From this Aled can fully utilise the grass he is growing because he can plan stocking rates and buy in feed when, and if he needs to in a cost effective way.

Rotational grazing has shortened the winter by two months which has halved the farm's requirement for silage, to 64ha.

"Our approach to grassland management has paid off as we are now growing 14 tonnes of dry matter (DM)/ha a year.

"We are not only growing more grass but our utilisation rate has increased to 85% from 70%. We have achieved this in part by changing the frequency of moving cattle to fresh grass, to a daily shift instead of every three days."

Sustainability

Aled has calculated that grazing grass costs the farm about 5p/kg DM, compared with silage at 12p/kg DM and concentrates at 20p/kg DM.

The more grass he can grow, the more profitable and sustainable his business. The concentration on improving grass utilisation has also led to better soil structure and soil health, both of which have positive biodiversity and environmental benefits.

Aled's approach to maximising output from grass means that the farm's basic payment accounts for less than 10% of farm income.

Farm Facts

- 212ha farmed including Rest Farm in conjunction with two other units within a seven-mile radius.
- Grazing 650 dairy-cross cattle at one time
- 700 breeding ewes
- 700 store lambs finished in a profit-share with another farmer

08 | **Feed**

Providing optimum nutrition (protein, energy and minerals) is needed within any productive beef and sheep system. This can be achieved by using forage analyses, livestock weights, estimating intake and targeting performance levels to develop a feeding regime whether it is allocating the correct grazing area or identifying supplementation requirements.

In order to ensure that animals are having the correct nutrition it's essential to fully understand their requirements and what is being provided by their current diet. Testing animal feeds and forage (including silage) supports this and can ensure profitable, well balanced rations which in turn help to avoid nutritional disorders.

Feed efficiency is a measure of how much liveweight gain is achieved per kilogram of dry matter consumed. More efficient animals will need to eat less while still performing at the equivalent or improved rate to their contemporaries; this also means they will have lower methane production. Feed efficiency is challenging to measure without specialist equipment, so a focus on maximising the amount of grass and forage in the diet is needed.

Bought-in feed can be one of the biggest costs for beef and sheep businesses and within a carbon footprint assessment the emissions used to grow the crop (mainly carbon dioxide and nitrous oxide) are included. The aim should be to minimise the amount of purchased feed by maximising the utilisation of home-grown grass and forages and only using bought-in feed to fill - or supplement - any energy or protein deficiencies.

This objective needs to be managed carefully. Consideration needs to be given to the genetics of the livestock on farm and how effective they are at converting grass and forage into meat. In order to minimise the need for purchased feed, lambing and calving dates can be managed to coincide with spring grass growth.

However, an excess of protein in animal diets can lead to higher nitrous oxide emissions from manures, slurries and urine deposits. It can be challenging to capture and make use of protein when grazing grass or forages as they will tend to have high levels of protein, which is related to the stage of growth, amount of clover present and use of nitrogen fertiliser.

When animals are housed, ensuring optimum nutrition can be easier to manage, as rations will be formulated to make sure the appropriate amount of protein for the energy intake required. It is crucial that livestock receive the correct protein:energy ratio in their diet as this will ensure nutritional efficiency within the rumen, reducing emissions and maximising livestock productivity.

The impact of processed animal feeds on deforestation and ecosystems around the world is an issue of significant public debate. Much of the feed used in livestock farming is derived from UK-sourced food by-products such as brewers' yeast, and the beef and sheep sectors account for a very small amount of the total imports of soya into the country.

Even so, there are options to further reduce the reliance on soya in the diet by using legumes such as lupins, peas and beans fed as grain while forage options to reduce need for supplementary protein include silages made form red clover leys, lucerne or sainfoin.

Stephen and Kate **Jones**

Meeting marketing requirements

The family business that Stephen and Kate Jones run at Kinnerton, Presteigne, is made up of sheep and suckler cow enterprises. There are also free range hens on the farm. The business supplied lambs for HCC's Welsh Lamb Meat Quality Project - which is an element of the Red Meat Development Programme.

What we're doing

"No farm business can afford to stand still which is why we have evolved our system to meet the changing demands of the market. Our enterprises complement each other well and help us to balance our labour requirement throughout the year.

"As farmers we need to understand the link between inputs and output. Every part of our business must stand on its own two feet so knowing our cost of production allows us to make informed marketing and business decisions."

Farming system

Lamb is produced from a mixed flock of 800 Scotch Mules, Welsh Mules, White Welsh Mules and Suffolk x Mules.

Around 400 lambs are sold straight off the ewe at an average deadweight of 18.5kg; weaned lambs average 19kg deadweight.

Beef is produced from a spring-calving herd of 25 British Blue and Limousin dairy cross suckler cows.

Sustainability

Involvement in the Welsh Lamb Meat Quality Project has provided the Jones' with data that reinforced their confidence in their system of producing sustainable and high-quality lamb.

"Initial results from the project has shown that our wether lambs had good performance and growth rates compared to other classes of lambs.

"We were pleased to be part of the project as being as efficient as possible and offering quality produce will make Welsh farmers competitive against overseas producers."

The Jones' have a good awareness of their costs and use the resources they have to optimum their system in a simple and sustainable way.

Farm Facts

- 162 hectares farmed
- Flock typically scans at 190%
- An arable rotation of 24ha of winter wheat, winter oats and spring barley, mostly used for home consumption

09 | **Manure Management**

Manures and slurries are an important source of nutrients - nitrogen, phosphate and potash - for grazed grassland, silage and arable crops. These are also an important potential source of the greenhouse gas nitrous oxide, so care is needed to make sure they are used appropriately. Correct and targeted use of manures and slurries can reduce and even replace the requirement for purchased fertiliser. Applications of any manures, slurries or fertilisers are most efficiently taken up by the plant when the pH is correct for the crop concerned.

Ideally slurry should be applied using a low emission method, such as an injector or dribble bar for slurry, onto a growing crop, and manures need to be incorporated within 12 hours. This is particularly important in spring and summer when air temperatures are high to avoid losses to the air. Consideration should be given to ensure that ground conditions are suitable when applying slurries, manures and fertiliser. Waterlogged or frozen soils should be avoided as the plants will not be growing or utilising nitrogen so there is a risk of the nitrogen being lost to the groundwater or the air.

Slurry and manures need to be stored to minimise any rainwater entering stores and heaps to avoid dilution and loss of nutrients. Careful composting of manures can concentrate phosphorus (P) and potassium (K) levels and reduce the time and energy needed to spread onto target areas. Analysing slurry and manure samples enables more accurate nutrient planning to take place. The results can be used to refine a nutrient management plan, along with the soil test results, to ensure optimum use of slurry and manures. Stored manures and slurries are sources of methane and nitrous oxide, therefore correct storage and management is important.

Managing and applying slurries/manures correctly will have considerable benefits to a farm enterprise, both in terms of performance and financial output. Ideally slurries and manures should be used to satisfy grass or crop requirements, with artificial fertiliser used to supplement as required, ultimately if this is achieved then the total volume of inorganic fertiliser used should decrease. This should considerably reduce cost and emissions. However, care is needed to ensure that as many of the nutrients from the organic materials as possible are available to the growing plant. For these reasons it is imperative that farms have a nutrient management plan which is used and regularly updated.

10 | **Fuel and Energy**

While beef and sheep production in Wales is a low user of energy and fuels, there will be area of improvements in every business. Fuel and energy use can be monitored to highlight activities that are costing money and to identify areas of high usage and also distinguish any leakages of resource. It is likely to be seasonal and dependent on the tasks needed, for example fuel for quad bikes are likely to increase during lambing on a sheep farm.

To reduce energy and fuel losses from the system it is important to ensure all farm equipment, vehicles and buildings are well-maintained or replaced with more energy-efficient models when possible. Some savings and reduced usage could be achieved through planning any journeys between holdings, markets and abattoirs to reduce fuel consumption.

The non-intensive nature of Welsh beef and lamb production means that it does not draw heavily upon electricity and natural resources such as water. Nevertheless, there are still ways in which the Welsh red meat sector can contribute to national targets by reducing fuel use, utilising more renewable energy and reducing emissions.

Many Welsh farms have already developed and invested in renewable energy sources. The overall aim is to reduce carbon dioxide emissions. The options include:

- **Solar thermal** - where the sun is used to heat water.
- **Solar photovoltaic** - where solar panels are used to generate electricity.
- **Hydro-electric** - where water is used to generate electricity.
- **Wind turbines** - where wind is used to generate electricity.
- **Biomass** - when waste wood or short rotation crop (e.g. willow, coppice and poplar) are harvested and burnt to generate heat.
- **Biogas** - can be produced from anaerobic digestion plants and can be burnt to generate heat and power.

It is important that due consideration is given to the suitability of renewable energy options, for example micro-hydroelectricity schemes, solar panels, wind turbines, biomass fuel production, planting or using trees, and short rotation woodland or short rotation coppice. A range of schemes are available that could support the farm through the development of renewable energy options, but not all options suit every farm.

Furthermore, renewable energy provision could be an important source of diversified income, as demand for renewable energy sources increases. While continuing to seek opportunities for increased amount of renewable energy to be produced on Welsh farms is important, it should be noted that due to the current national accounting method for calculating emissions from different industries any renewable energy generated on farm is not reported against agriculture. This means that under the current reporting methodology any on-farm renewable energy creation cannot be used to offset emission associated with beef and sheep production.

Mains water can be a cost to many farm businesses, but can also generate some level of emissions due to all the processes needed. A significant proportion of beef and sheep farms in Wales have exploited opportunities to harvest springs, drill boreholes, install pasture pumps for rivers or streams or to harvest rainwater. Further opportunities to develop this can support the farm infrastructure and reduce potential issues; especially if it is aiming to prevent livestock accessing watercourses. Fencing off watercourses will also help biodiversity and carbon storage on the farm.

11 | **Carbon Balance (Sequestration)**

Welsh beef and sheep farms are in a good position to lower their carbon footprint through improved production efficiency and carbon offsetting, through storage or sequestration. Through the effective use of grassland and other natural resources there is a possibility to sustain or enhance the levels of carbon that is sequestered or stored into the soil and vegetation.

There are many farming practices which improve soil health and encourage carbon sequestration and storage. Examples include minimising cultivation (both in terms of frequency and depth), using perennial crops which allow organic matter to build up, having diverse cropping systems and minimising poaching and soil compaction.

Changes in soil carbon tend to occur over many years, and the potential for sequestration is highly dependent on soil type. Soil carbon is not stored permanently. Turn-over of soil organic matter occurs continuously over a range of timescales and is sensitive to management and climate factors, resulting in some soils being a net source or net sink of organic carbon.

Carbon storage in soils also tends to reach a plateau unless management changes occur. For example, soil carbon storage will reduce if the ground is cultivated whereas soil carbon can increase if manure returns are increased. Carbon sequestration in both soils and vegetation such as trees and hedges therefore provide a valuable opportunity to off-set greenhouse gas emissions.

As many UK soils are relatively rich in organic carbon compared to other countries, there may be challenges to significantly increase carbon stocks. It is important to understand the current status of the soils and if the soil carbon levels have plateaued then the focus becomes managing the considerable stored carbon by avoiding erosion by using buffer strips or minimising cultivations. For example, ploughing permanent grass for arable crops can lead to over 2.5 tonnes per hectare of stored carbon being released.

If there are degraded peat areas on farm, these need to be prioritised, as they have the highest potential for carbon storage. Degraded peats can release significant amounts of carbon, therefore restoring these can make a considerable difference to a farm's carbon footprint.

Managing hedges to grow taller and wider could offer a simple and cost-neutral way to increase sequestration rates on farm. Establishing additional hedges and trees in suitable locations, e.g. along fence lines or on unproductive land could make important contributions in reducing whole-farm carbon footprints, especially once trees reach the mature phase where sequestration rates are high. As well as sequestering carbon above-ground and in soil; trees and hedges planted appropriately can also improve the efficiency of production through improved shelter for animals. Having this physical barrier between field boundaries can also support an increase in a farm's bio-security status where nose-to-nose contact between neighbouring animals is avoided. There would also be the added potential for increased biodiversity through streamside and boundary corridors.

In the carbon footprint project reported in The Welsh Way, hedges offsetted 2-7 per cent of emissions on the 20 beef and sheep farms studied. Woodland on hill and upland farms offsetted up to 29 per cent of emissions and the results from the lowland farms showed that isolated trees offsetted up to 34 per cent of emissions from the beef enterprises. The amount of emissions offset on each farm varied depending on total emissions and the type of vegetation on the farm but the results highlights the potential and importance of including sequestration when looking at emissions associated with beef and sheep production.

Selection for slaughter – meeting market requirements

Accurate assessment and selection of finished beef cattle and lambs for slaughter is an important component of sustainable production.

As an animal grows, the tissues that comprise meat grow and mature at different rates. The energy intake of a growing animal is first directed to bone growth and then to muscle growth and once these demands are met, any excess energy is stored as fat. The energy cost of depositing fat is about six times that of depositing muscle so cost-effective animal production must match the dietary supply with the need for tissue growth to produce lean meat required by the market.

Allowing animals to become overfat is costly from both a feed and forage point of view, because of the penalties that may be incurred in the abattoir, and from the increased emissions from livestock that are held on farm longer than is necessary. Knowing when to market animals will avoid costly overfeeding, help to reduce any penalties from over-fat or over-heavy carcasses, and ensure methane emissions are kept to a minimum.

Regular weighing of finishing cattle and lambs is extremely important to determine slaughter date. When a finishing animal's daily weight gain starts to decrease, this is an indication that the animal is nearly ready for slaughter, so by regularly monitoring how animals are progressing towards finish, it is possible to adjust feeding regimes to bring livestock to market at the most opportune time.

Certain breeds are known for their carcase traits as they have been selected for many years for muscle development in certain parts of the animal. The ability for the animal to express this genetic potential is linked to nutrition and health.

Bulls can be selected for estimated breeding values (EBVs) on carcase weight, muscle depth, eye muscle area, retail beef yield and fat depth. Rams can be selected for EBVs on muscle depth and fat depth, plus additional traits from computed tomography (CT) scanning for some breeds. Selecting on EBVs provides additional information about the genetic potential of that animal.

The ambition is that the emissions generated over the lifetime of the animals will be spread over more kilograms of in-specification meat. For suckler cow and breeding ewe systems the meat produced by their offspring is also carrying their emissions, so the aim should be to reduce the emissions per head. The other benefit is that the use of superior genetics when aligned with good management will mean more profitable red meat production.

One of the drivers for productivity and also profitability is days to slaughter. This is a combination of growth rates and finish level. For cattle, most of the gain should be from grass or forage, with some systems using additional supplements in a short finishing period to lay down finish. It is important to think about the cost of over-wintering the animals for a second or possibly a third winter. For lambs, the aim is to maximise the number finished off grass or forage, with strategic use of supplementary feed if required. To support, bulls can be selected for EBVs on muscle depth, 200-day weight, 400-day weight, 600-day weight, and fat depth EBVs. Rams can be selected on EBVs for scan weight EBVs (growth rates to four to five months), muscle depth and fat depth. Carefully selecting animals to meet the system's needs, based on these EBVs, will support increased efficiency.

The aim should be to have the animals on farm for as few days as possible while meeting market specifications, this will be particularly effective when achieved on a grass-based system which will reduce potential greenhouse gas emissions. Within some systems there may be a trade-off between buying in feed to improve growth rates and reduced days on farm. The aim would be to get as much growth gain as possible off grass or conserved forages, with inputs used to supplement and to answer any gaps in energy and protein.

The importance of continuous improvement

The mitigation actions that have been highlighted in this document will all have the potential for improving productivity while also lowering the greenhouse gas emissions associated with red meat production. There is a need to take a holistic approach to managing farm systems and seeking improvements - the cumulative nature of the improvement should significantly outweigh the outcome of a single action.

As part of The Welsh Way, HCC analysed the potential net effect of a number of improved performance indicators from the beef and sheep sector on GHG emissions. This work was undertaken by RSK ADAS; and analysed data from the National Inventory.

The data showed that improvements in animal performance measures have the potential to markedly reduce the intensity of greenhouse gas emissions, especially methane. This includes improvements such as addressing overall feed intake, reducing finishing time, increasing the number of animals finished per breeding animal and reducing the number of replacement animals carried on farm.

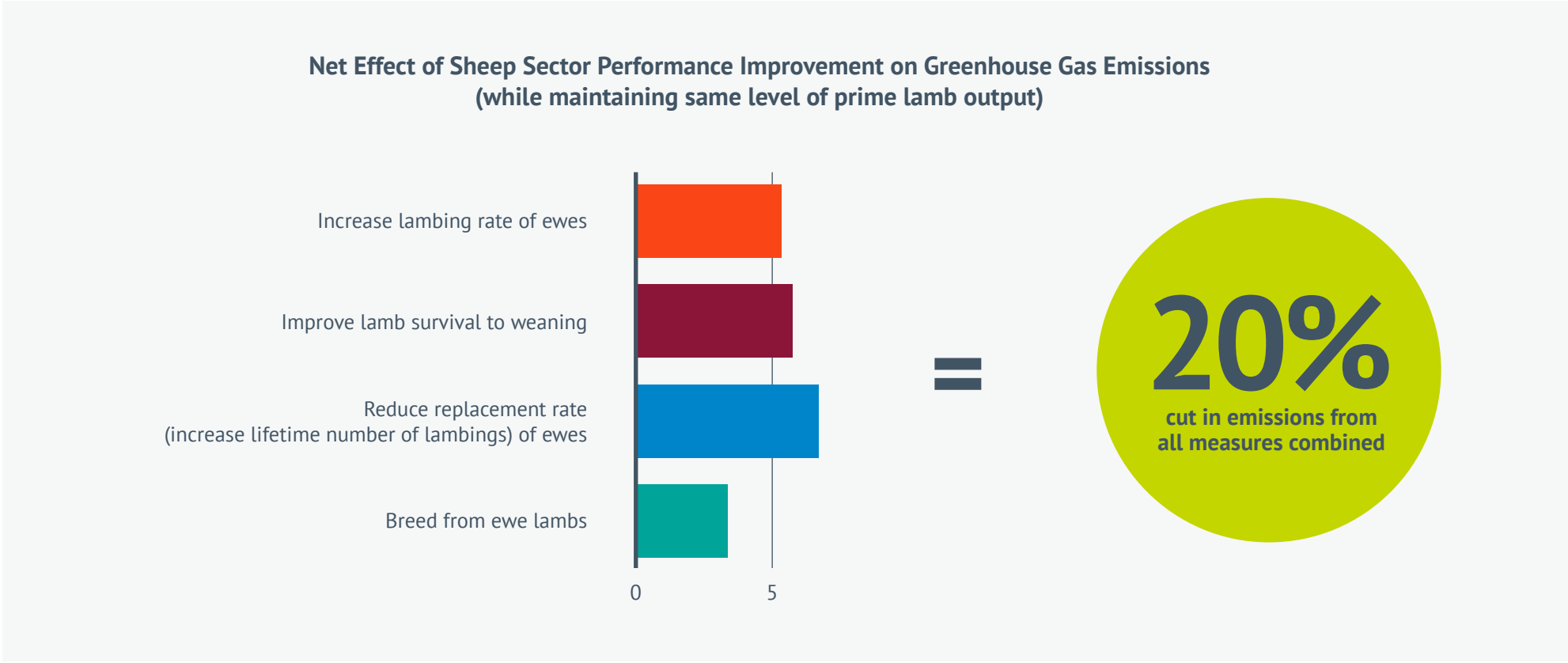
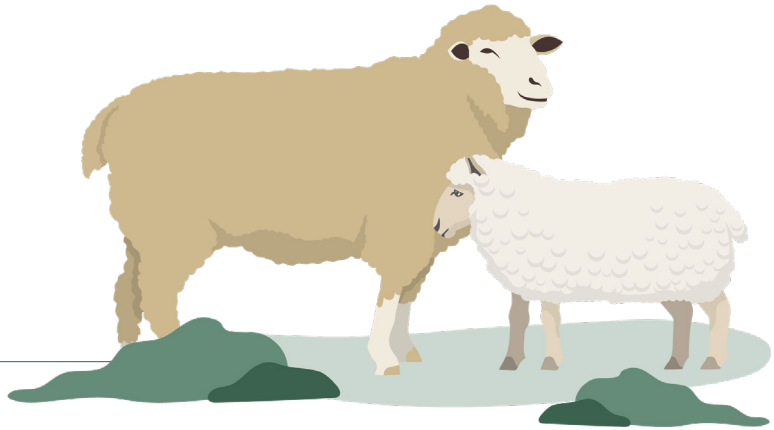


Figure 03

Source: HCC commissioned research by RSK ADAS. 2020.

For the sheep sector (see **Figure** 03), a combination of gains in all performance measures delivered an emissions reduction of 20.4 per cent. A selection of measures individually delivered a 5.7 per cent reduction from the production of additional lambs per mature ewe put to the ram. Also, there is a 5.9 per cent emissions reduction from improved lamb survival; a 4 per cent reduction from the widespread adoption of breeding from ewe lambs; and a 6.1 per cent reduction from extending the productive lifetime of a mature ewe.



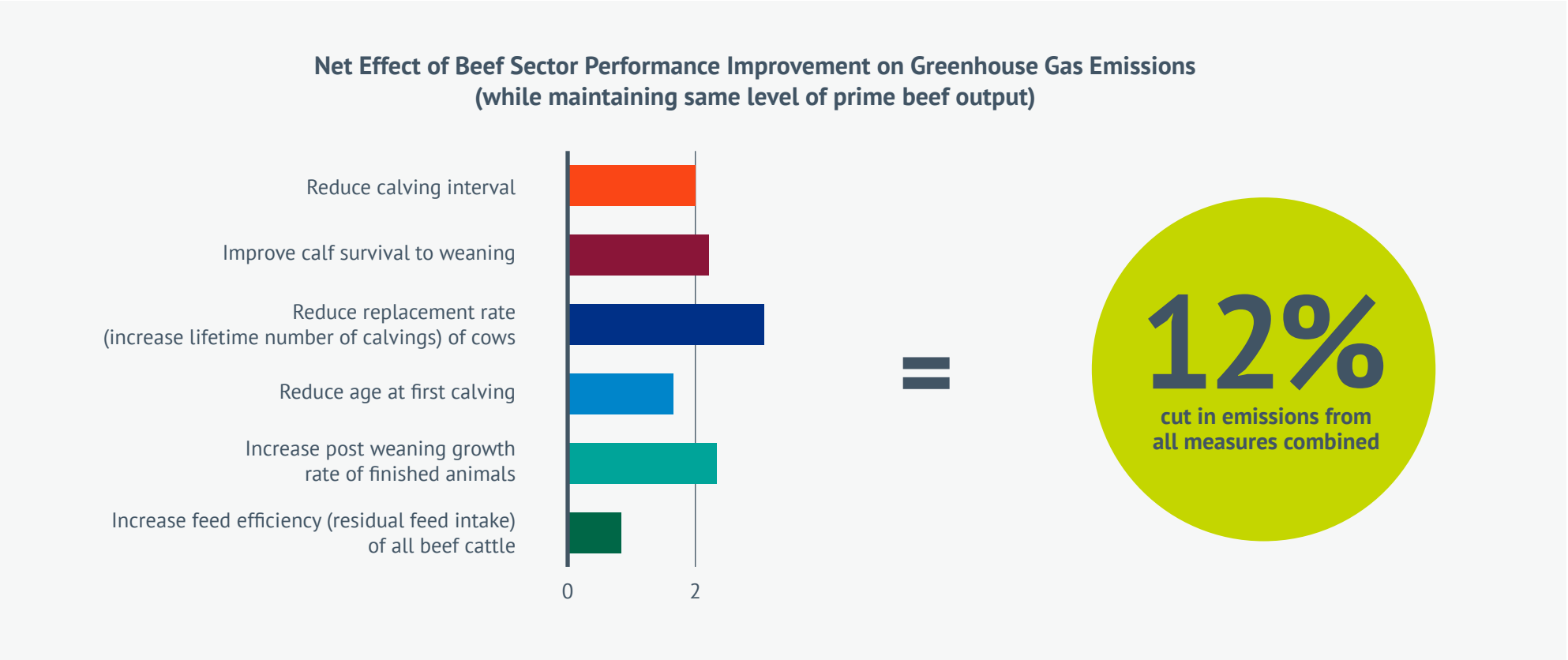


Figure 04

Source: HCC commissioned research by RSK ADAS. 2020.

For the beef sector, a combination of gains in all performance measures delivered an emissions reduction of 11.6 per cent (see **Figure** 04). A selection of measures individually delivered a 2.1 per cent reduction from a reduction in calving interval from 426 to 400 days; a 2.5 per cent reduction from a 10 per cent increase in post-weaning growth rate; a 1.7 per cent reduction as age at first calving was reduced from 34 to 28 months; and a 2.2 per cent emission reduction from improved calf survival. Potential gains in the beef sector were diluted by a large (45 per cent) contribution of calves sourced from the dairy herd that did not benefit from beef suckler cow improvements in calf rearing.

As the figures demonstrate, the cumulative impact of the actions highlighted would have the potential for a 20 per cent reduction in sheep sector emissions and an 12 per cent reduction in beef sector emissions (all other things being equal) while the total volume of prime lamb and prime beef output would remain constant.

These figures were derived through looking at the GHG associated with direct performance of the animal, this combined with improvements in indirect potential sources (and sinks) of emissions from production such as soil and grassland management would have an even larger impact on lowering greenhouse gas emissions from red meat production in Wales.

Where to start

It is essential that Welsh farms are able to understand their emissions impact, decarbonise and reinforce any claims made in relation to greenhouse gas emissions. To do this there will be a need to undertake a farm carbon footprint. There are various calculators available that are suitable for Welsh beef and sheep farms however there are some challenges in relation to measurement. There are tools available online for free or for a small fee, there are also tools available as part of farm software packages. The carbon footprint can be calculated by product (for example, kg of lamb), by enterprise and for the whole farm.

It is critical to understand the focus of the tool used and the methodology it uses to calculate the carbon impact. Different tools may use slightly different methodology, they also approach certain impacts critical to the carbon footprint in different ways, such as carbon sequestration and land-use change.

They key to calculating an accurate carbon footprint requires good, reliable farm data concerning both inputs and outputs. This can sometimes be more challenging across beef and sheep farms due to the split of rearing and finishing, however many tools can accommodate this provided that production data is captured.

Carbon calculation is a rapidly evolving area with the main calculators constantly being reviewed and updated both in terms of developing science and adjusted input values. Ideally, data on farm performance should be inputted annually using the same tool to create a fair comparison, by doing this - and comparing results with others - areas of potential improvement can be identified.

It is impossible to target everything at the same time, so there is a need to identify areas that are likely to have the biggest impact - be that economically, environmentally or socially. Once the 'what' has been have identified an action plan can be used to work out the 'how'.

The most sustainable farms are the ones that match their production to their resources. The key is to investigate and identify the cause of sub-optimal performance as quickly as possible. Once this is achieved then plans can be developed to support improvements.

Carbon credits

In the last decade there has been much discussion regarding the opportunities that may arise to trade in carbon credits based on agricultural land.

There is an increasing need for businesses and governments to voluntarily 'offset' greenhouse gas emissions they are unable to abate, through the purchase of carbon credits. There may be potential for farmers to benefit from this market in the future through on-farm carbon off-setting projects such as peatland restoration, woodland creation and a change in land management practices that improves carbon sequestration in soils (e.g growing legumes in rotation and zero tillage). The amount of potential carbon sequestered by the project or activity is quantified to create carbon credits, with one carbon credit equating to one tonne of carbon dioxide equivalent (CO_2e). Once measured and accredited the carbon credits may be traded.

Currently, the market remains unregulated despite the increasing focus on trading of credits by a range of industries. To date, the price paid for carbon credits has been highly variable and the market is likely to change and develop rapidly.

Whilst there is potential in trading carbon credits derived from farm-level sequestration activity, caution must be advised. It is likely that the market will become more structured in the near future, and that the price of carbon may well increase. A number of private sector companies and other organisations – many of whom are from outside the agricultural sector – have been seeking to purchase carbon credits to offset emissions of other industries. If carbon credits from farmland are traded in this way, the opportunity to offset agricultural emissions will be removed.

It is also vital, before considering trading carbon credits, that farms have a sound understanding of their own carbon footprint. Without this knowledge, it is possible that in the future some farm businesses could face the scenario of having to buy in credits to offset their own emissions at a higher cost than the price originally paid by outside companies for their farm sequestration potential.

Overall, the development of the carbon credit market may offer beef and sheep producers in Wales an opportunity to generate new income streams into their businesses. However, as with all fledgling or unregulated markets, caution should be advised until a clear understanding of the potential of this area is reached.

Conclusion

The task of achieving significant emission reductions within the red meat sector should not be underestimated and will require changes across many aspects of livestock and farm management. There are very few quick fixes. Changes cannot generally be seen in the same breeding season or within 1-2 seasons. It is recognised that many of the changes needed will take a long time before their effects are visible at farm level and even longer before the impact will be reflected in national performance indicators. But this is not a reason for inaction.

Due to links between emissions and physical and financial performance, the key to targeting approaches is to fully evaluate current performance. There are a range of benchmarking services available to farmers, however simple calculations can be done on paper or on spreadsheets.

Once targets have been established, the next step should be to seek improvements, this should be done regardless of current performance - there is always room for improvement. Following a continuous improvement programme will allow the industry to become more sustainable.

Beef and sheep production in Wales is in an advantageous position. The climate and terrain seen on Welsh farms is best suited to pasture and livestock farming that support sustainable red meat production. As such the farming systems seen in Wales differ significantly to other more intensive systems seen in some other parts of the globe. The challenge for the Welsh beef and sheep sector is to meet Government targets on greenhouse gas emission reduction while continuing to produce high-quality nutritious beef and lamb, while supporting and developing the farm's natural capital. This aim can be achieved through increasing productivity, optimising the sequestration potential and enhancing the renewable energy generation on farm.

Definition of terms

Global warming potential (GWP100) - this is a way of comparing how efficient the different gases (which have different efficiencies) are at trapping heat.

Global warming potential (GWP*) - this is a way of comparing how efficient the different gases (which have different efficiencies) are at trapping heat, while considering that methane breaks down quickly in the atmosphere compared to CO_2 and N_2O.

Carbon dioxide equivalent (CO_2e) - this is a unit of measurement that accounts for the gases' different global warming potential.

Carbon dioxide warming equivalent (CO_2we) - this is a unit of measurement that accounts for the gases' different global warming potential and the different rate of breakdown.

Carbon intensity of each kilogram product - this is the total emissions divided by the kilograms of product (liveweight sold off the farm).

Climate change mitigation - activities to reduce or prevent greenhouse gas emissions or remove CO_2 from the atmosphere, e.g. reduced days to slaughter through improved grassland management, or planting additional trees.

Soil carbon - this is what is stored in the organic matter in the soils with organic matter being around 50 per cent carbon.

Carbon sequestration - the removal of carbon dioxide from the atmosphere into a store, such as trees or organic matter in soils.

Carbon storage - the amount of carbon already being stored in soils and vegetation.

Carbon sink - when more carbon is being removed from the atmosphere than it being released, e.g. in organic matter in well-managed grassland or peatland and in trees.

Carbon source - when more is being released to the atmosphere than it being stored, e.g. cultivating soils or degraded peat soils.

Carbon trading - when carbon that is being stored in soils or in woodland is traded to offset the carbon emissions in other industries, e.g. air travel or heavy industry. Some farms are already part of these commercial ventures and are getting paid for managing their land to maximise carbon storage and sequestration.

Carbon footprint – in the context of this report, this is the quantity of greenhouse gases that are released due to the production of meat. It will include questions on manure storage and management, fertiliser and feed use and any land change. Various tools are available to help farmers measure their farm's carbon footprint and it may be a requirement from a processor. The approach each tool uses varies, especially if they take into consideration carbon stored in and captured by soils, hedges and woodland.

Net zero - when the emissions released from production , which have been reduced through improved on-farm practice, is balanced by carbon storage on farmland.

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