Reducing methane emissions through improved lamb production

HYBU CIG CYMRU
MEAT PROMOTION WALES

www.hccmpw.org.uk

Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig: Ewrop yn Buddsoddi mewn Ardaloedd Gwledig
The European Agricultural Fund for Rural Development: Europe Investing in Rural Areas

Llywodraeth Cynulliad Cymru
Welsh Assembly Government

Hybu Cig Cymru / Meat Promotion Wales
Tŷ Rheidol, Parc Merlin, Aberystwyth SY23 3FF
Tel: 01970 625050 Fax: 01970 615148
Email: info@hccmpw.org.uk

www.hccmpw.org.uk

April 2011

Design Hybu Cig Cymru 2011
Technical content IBERS, KN Consulting, Innovis 2011

This project has received funding through the Rural Development Plan for Wales 2007 – 2013 which is funded by the Welsh Assembly Government and the European Union.

Contents

Introduction

The issue of greenhouse gas emissions from agriculture is being increasingly recognised by government and consumers. The Welsh Assembly Government has set out, as part of the One Wales Agreement, a commitment to reducing greenhouse gas emissions by 3% per year from 2011.

Ambitious UK targets set through the Climate Change Act 2008 aim to cut emissions of all greenhouse gases by 80% by 2050. With greenhouse gas emissions from primary agricultural production contributing around 9% of total annual Welsh emissions this is an issue with ever increasing relevance to Welsh livestock production.

This booklet aims to provide sheep farmers in Wales with essential information on how livestock contribute to greenhouse gas emissions and it considers some practical solutions which may contribute to reducing emissions from sheep production. Genetic improvement is one such tool which has been shown to increase flock productivity and may also make a valuable contribution in reducing greenhouse gas emissions from lamb production.

Using all available tools to improve the efficiency of Welsh Lamb production can play an important part in the solution to climate change and will help to ensure that the Welsh sheep industry is set to meet these coming challenges.

Greenhouse gas emissions from sheep production

There are three main greenhouse gases:

- Carbon dioxide (CO_2)
- Nitrous Oxide (N_2O)
- Methane (CH_4)

Whilst livestock farming is responsible for the production of some carbon dioxide it is nitrous oxide and methane which make up the majority of emissions. On a like for like basis, both nitrous oxide and methane have a higher 'global warming potential' than carbon dioxide. Methane is approximately 21 times more damaging to the atmosphere compared with carbon dioxide, whilst nitrous oxide is about 300 times more potent. The damaging effect of these gases means their reduction is vital.

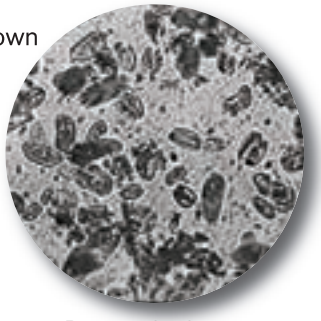
Nitrous oxide and methane are the results of different processes. Nitrous oxide is largely released from soils and the use of fertilisers, whilst methane is produced from ruminant digestion and the storage of manure. Where carbon dioxide is produced it is generally as a consequence of soil disturbance, fuel use and manufacturing processes.

Given the varied agricultural systems in Wales and individual farm management practices, the actual proportion of the three gases produced from different farms will vary considerably.

For sheep production, reducing methane emissions is the main challenge. It is the process of turning relatively poor quality forage unsuitable for human consumption into meat (a valuable source of protein) that contributes to the production of methane.

How is methane produced?

The majority of methane is produced as part of the natural fermentation processes that take place in the rumen. This is known as enteric fermentation and the methane produced is known as enteric methane emissions.



Rumen microbes

During digestion, the microbes resident in the digestive system ferment the feed and forage consumed by the animal. This microbial fermentation process (enteric fermentation) produces methane as a by-product. This is exhaled or eructated by the animal (burped and belched). In fact the majority of methane produced by ruminants is 'burped' from the mouth and nostrils.

It is the rumen microbes (bacteria, protozoa and fungi) which are responsible for the breakdown of forage and it is the products of this process which are absorbed into the bloodstream of the animal.

The actual amount of methane produced by an animal depends on various factors: level of feed intake, feed quality and differences in an animal's own efficiency of food conversion.

Measurement of methane emissions from lambs being carried out by Aberystwyth University

Research also suggests that there are differences in methane emissions between individual animals. The reasons for some animals being 'low emitters' is an area being pursued by further research.

The amount of methane emitted from manure storage is lower for sheep compared to other livestock. Sheep are generally kept outside and therefore the anaerobic conditions needed to produce methane from manure tend not to occur. The main focus on reducing methane output from sheep production is therefore in reducing the methane emissions from the rumen digestive processes.

How can we reduce methane emissions from our sheep?

There are different approaches to reducing methane emissions from sheep production.

Nutritional strategies

Changing the diet is one way of reducing the amount of methane produced from an individual animal. This can be achieved through the use of different types of feed or through the introduction of additives into the diet.

Methane emissions are affected by diet

Research work being carried out in Wales includes;

- Using plant extracts such as garlic
- Using grasses high in water soluble carbohydrates (High Sugar Ryegrasses)
- Breeding new varieties of cereals such as high lipid content oats

Increasing efficiency

Another approach is to focus on reducing methane emissions per kilogram of product.

A significant amount of the energy that an animal needs is used simply to maintain it in a healthy state – an animal's maintenance requirement. For non-productive animals this accounts for all of their energy requirements.

Once the basic requirements for maintenance are met, energy is also needed for production: for growing, for pregnancy, for lactation and for wool. The total amount of energy required therefore increases with increasing production, but the energy required for maintenance generally remains constant.

Methane production is linked to energy requirements and feed intake therefore although increasing production increases the total energy requirement (and methane produced), the proportion of energy that is required for maintenance is reduced. When levels of production are taken into account, the overall methane emissions per unit of output e.g. kg of lamb or wool is lower for more productive animals.

Improving animal productivity is one of the key ways to reduce methane emissions per unit of product.

Whilst improving productivity is one of the key principles to reducing methane emissions, for this to be effective it has to be driven through better efficiency rather than by higher inputs.

One of the most cost-effective ways to improve production efficiency is the use of genetic improvement.

Genetic improvement is driven by the identification of individual animals which are superior in their performance and are able to pass on some of this superiority to their offspring.

Estimated breeding values are used to predict the genetic superiority of the animal taking into account their own performance, performance of their relatives and allowing for advantages such as litter size and growth rate.

Estimated breeding values are available for;

- Weight at 8 weeks of age
- Weight at 21 weeks of age
- Muscle depth
- Fat depth
- Litter size (prolificacy)
- Maternal ability (milking ability)

Commercial producers are able to select rams that have been selected for key performance traits.

Genetic improvement has already been shown to play a vital role in improving production efficiency. Typical benefits of using high index rams have been £2 to £3.50 per finished lamb: this can be considerably more when female replacements are retained.

In order to compare animals on a number of different traits estimated breeding values are combined into a single figure; an Index. This provides an overall figure for the genetic worth of an individual animal. The precise combination of traits in the Index will vary according to the production requirements of different breeds and systems.

Typical Indexes used in Wales

Index	Typical breeds	Aim	Contributing Estimated Breeding Vales
Welsh Index (Carcase +)	Welsh Mountain Beulah Speckle Hill Speckle	To enhance maternal ability, lamb growth and carcase quality	Maternal ability Scan weight Muscle depth Fat depth
Longwool Index	Bluefaced Leicester Border Leicester	To enhance lamb growth rates and carcase quality	Maternal ability Scan weight Muscle depth
Terminal Sire Index	Charollais Suffolk Texel	To increase lean meat yield in the carcase whilst limiting any associated rise in fatness	Scan weight Muscle depth Fat depth Gigot muscularity

Impact of increasing productivity on methane emissions

Increasing rearing percentage

A ewe rearing twins will produce more methane (due to higher feed requirements) than a ewe that rears a single. However, she has produced double the amount of product so the amount of methane produced per kg of lamb output is lower.

Not all farming systems can aim for many multiple reared lambs. In which case maximising the number of ewes rearing a lamb to market specification is a key component of flock productivity.

Increasing growth rate of slaughter lambs

Increasing growth rate reduces the amount of time a lamb is on farm. This in turn reduces the amount of methane produced per kg of lamb output.

Increasing longevity

Female replacements produce methane for their own maintenance and growth without producing any output (excluding wool) until they produce their first lamb. Reducing the number of replacements required and removing any barren or underperforming ewes from the flock will reduce flock methane emissions since more ewes are contributing to flock output and their methane output is spread over a greater weight of lamb produced.

Impact of genetic improvement on reducing methane emissions

Reduction in methane emissions

Performance recording and the use of high index stock has already been shown to improve flock productivity. A unique model has now been produced that will help to estimate the reduction in methane emissions that could be achieved in the Welsh national sheep flock through the use of genetic improvement.

The model considered the change in methane emissions resulting from the improvement in performance of individual animals brought about through breeding from genetically superior stock. Methane emissions were subsequently predicted per tonne of carcase produced.

Due to the integrated nature of lamb production the structure of the industry was considered. Movement of breeding females from hill and upland flocks to lowland flocks is still the basis of lamb production systems in Wales.

This model therefore considered the predominant flock types in Wales:

- A hill flock with pure-bred hill ewes mated to a hill breed of ram
- An upland flock with hill ewes mated to a Crossing sire e.g. Bluefaced Leicester or Border Leicester
- A lowland flock with crossbred ewes (bred from the upland flock) mated to a Terminal sire

The genetic make-up of hill breeds has a considerable impact on the Welsh sheep industry through the impact of their crossbred progeny and their resultant slaughter lambs.

Each sector of the sheep industry makes a vital contribution to prime lamb production.

The effect of breeding for individual traits on methane emissions

Many different attributes are under genetic control and the key to genetic improvement is to identify animals whose characteristics improve profitability.

The model first considered how some of the traits which improve flock productivity could also reduce methane emissions.

The following traits were considered;

- Lamb growth rate
- Lamb muscle depth and carcase weight
- Lamb survival
- Ewe litter size
- Ewe longevity

The model considered the results for both a hill and lowland flock.

Increasing lamb growth rate without increasing ewe weight could lead to a reduction in methane emissions.

Hill flocks

The model estimated that for hill flocks, improving litter size, ewe longevity and carcase weight should lead to a reduction in methane emissions. Selecting on lamb growth alone can, however, lead to a slight increase in methane emissions because ewe weight will also increase along with her energy requirements. However, if lamb growth is improved without increasing ewe weight, methane emissions are significantly reduced.

Change in methane emissions per tonne of carcase expected from single trait selection in Hill Flocks over ten years

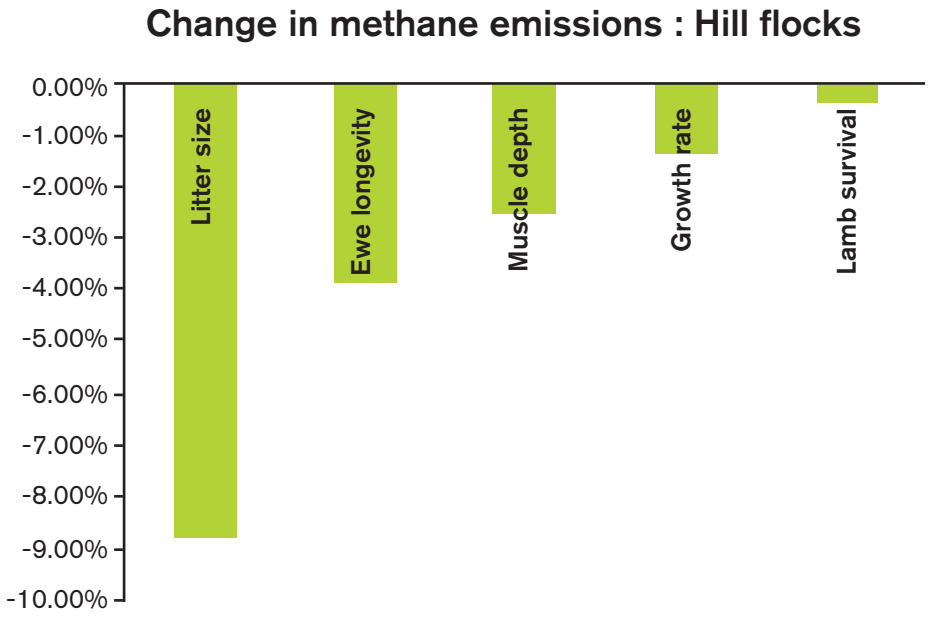
Performance trait	Percentage change in methane emissions over 10 years
Ewe litter size	-8.8%
Ewe longevity	-3.8%
Lamb muscle depth and carcase weight	-2.5%
Lamb growth (with no change in ewe weight)	-1.3%
Lamb survival	-0.3%
Lamb growth (with correlated increase in ewe weight)	+0.4%

The results above show the progress that can be made following selection on some individual traits. Traits expressed in the ewe show particular scope for reducing methane output per tonne of carcase.

Breeding for increased ewe longevity could help reduce methane emissions as well as reduce replacement costs.

Increasing ewe litter size made the highest contribution to reducing emissions whilst improving ewe longevity also led to a considerable reduction. Improving carcase weight through selection on muscle depth also led to a valuable reduction in methane output.

Impact of single trait selection on methane emissions from hill flocks



The results show the changes that can be achieved from genetic improvement alone. Maximising flock efficiency through changes in management will also reduce emissions. For example, improving traits such as lamb survival through improvements in flock management will lower methane emissions per tonne of carcase produced.

Lowland flocks

A similar exercise was carried out considering the impact on lowland production should all flock types' select on a single trait. Similar results were obtained and selection on all traits listed is expected to reduce methane emissions per tonne of carcase weight produced.

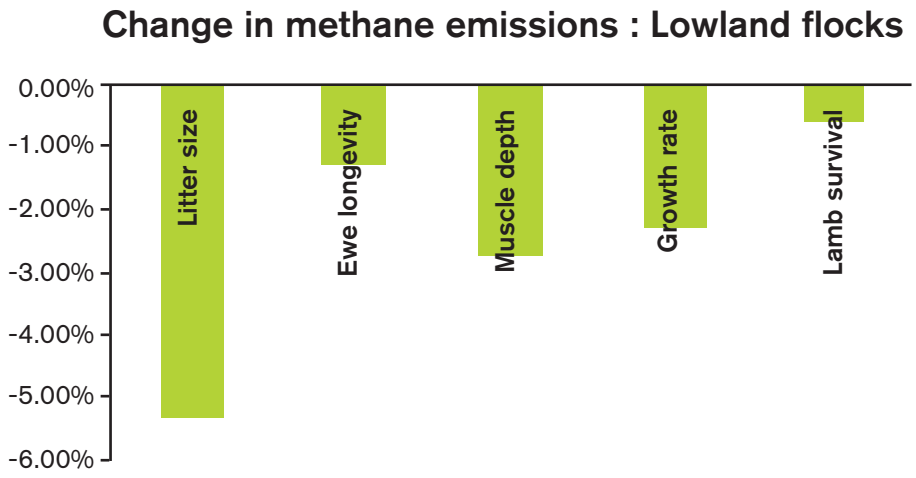
10 year change in methane emissions per tonne of carcase by single trait selection in all flocks

Performance trait	Percentage change in methane emissions over 10 years
Ewe litter size	-5.3%
Lamb muscle depth and carcase weight	-2.7%
Lamb growth rate (with no change in mature ewe weight)	-2.3%
Ewe longevity	-1.3%
Lamb growth rate (with correlated increase in ewe weight)	-0.7%
Lamb survival	-0.6%

Increasing litter size can contribute to reducing methane emissions.

Increasing ewe litter size continued to make the highest contribution to reducing emissions. For lowland flocks improving lamb growth rate and muscle depth also made significant contributions.

Impact of single trait selection on enteric methane emissions from lowland flocks



The results show the changes that can be achieved from genetic improvement alone. Maximising flock efficiency through changes in management will also reduce emissions. For example, improving traits such as lamb survival through improvements in flock management will lower methane emissions per tonne of carcase produced.

The effect of using selection indexes on methane emissions

In practice, genetic improvement identifies a number of traits for selection. Indexes have therefore been developed with the aim of improving overall animal productivity by the simultaneous improvement in a number of attributes. The model therefore considered the impact of selection using the appropriate indexes in hill, upland and lowland flocks.

Impact on Hill flocks

Selection on the Welsh Index could be expected to yield a 0.5% reduction in methane emissions over a 10 year period assuming no change in ewe weight.

Selection of hill ewes on the Welsh Index is also expected to significantly increase the weight of lamb weaned per ewe and to reduce the number of days taken to finish lambs. Over a period of 10 years hill flocks using the Welsh Index would expect to see nearly a 4% increase in weight of lamb reared and over 3% reduction in the days taken to finish lambs or attain a good selection weight in ewe lamb replacements.

Performance recorded hill rams can increase weight of lamb reared and reduce lamb days on farm.

Impact on Upland flocks

Using hill ewes bred from recorded rams and mated to recorded crossing sires would lead to a 1.3% reduction in methane emissions over a 10 year period (assuming no change in ewe weight). Using superior rams would also increase the weight of lamb reared by nearly 2%.

Selecting hill ewes bred from recorded hill rams and mating to recorded crossing sires can reduce methane emissions and increase the weight of lamb reared.

Impact on Lowland flocks

Lowland flocks using both improved crossbred ewes and performance recorded terminal sires would be expected to reduce their methane emissions by 1.8% over 10 years. Genetic improvement could also expect to increase weight of lamb reared per ewe by 4.5% and every kg of lamb produced would require nearly 2.5% fewer days to produce.

It is already possible to select crossbred females bred from performance recorded rams.

Summary

- Targets have been set for a reduction in greenhouse gas emissions from all sectors; public, private, transport and business
- Primary agricultural production is responsible for 9% of annual Welsh emissions
- Greenhouse gases include carbon dioxide, nitrous oxide and methane
- Methane from agriculture is typically produced from 2 sources: the fermentation of feed in the rumen (enteric emissions) and the management of manure
- A significant proportion of the methane emissions from the sheep sector is in the form of enteric methane emissions from fermentation of feed in the rumen
- There are different methods for reducing enteric methane emissions including nutritional approaches
- Increasing productivity can reduce methane emissions per kg of output
- Genetic improvement has already been shown to improve flock performance and profitability
- Modeling the impact of genetic improvement on methane emissions showed an increase in flock productivity and a reduction in methane emissions per tonne of carcase produced
- Further reductions in methane emissions can also be achieved through changes in management and nutrition.

Conclusion

Genetic improvement for traits associated with productivity can also lead to significant reductions in methane emissions per kg of carcase produced, with traits such as ewe litter size showing a reduction in methane emissions comparable to those that can be achieved through changes in diet. Genetic improvement, in conjunction with other management strategies, can therefore play a vital, long-term role in reducing enteric methane emissions and increasing the productivity of the Welsh national flock.

Further information on HCC's activities and other relevant publications can be found at www.hccmpw.org.uk