

Ruminations on climate change

Geneticist, cattle breeder and emissions expert, **Dr Yvette de Haas**, shares the details of her research into reducing methane emissions and agricultural costs by improving the efficiency of cows



Can you briefly describe your background and explain what led to your interest in this area of research?

My background is in animal breeding and genetics; I graduated from Wageningen University in The Netherlands, in 1999. The general objective of my work has been to use animal breeding as a tool to improve traits in dairy cattle. During my PhD I worked on udder health – trying to maintain their productivity while improving their wellbeing. For my postdoctoral studies I focused on the improvement of robustness, breeding cows that can live longer and adapt to changing environmental conditions. For the last couple of years my focus has been on improving resource efficiency; the main aspects I address here are improving feed efficiency – lowering feed intake while maintaining production – and reducing methane emissions.

How big a problem is methane emission on a global scale?

Climate change is a growing international concern and it is well-established that the

release of greenhouse gases (GHGs) is a contributing factor. The EU has committed to reducing its GHG emissions by 20 per cent by the year 2020, relative to 1990 levels. The global livestock sector, particularly ruminants, contributes approximately 18 per cent to the total anthropogenic emissions – in the EU this is reduced to 13 per cent. Of the various GHGs produced by ruminants, enteric methane is the most important contributor, with a global warming potential 25 times that of CO₂.

Are there advantages of measuring methane emission of individual ruminants, rather than a large number of livestock?

For breeding it is important that you have individual measurements; only then can you differentiate between the best and worst animals. The individual information will allow you the opportunity to select animals with the same milk production, health and fertility status etc., but which still emit less methane. You don't want to select for lower methane emissions by reducing the production level or making health or fertility worse! However, making individual measurements is particularly challenging because, as methane is a gas, measurements have to be done very fast so that they can be allocated to the right animal.

To what extent is a multidisciplinary and collaborative approach important to the success of your project?

I believe that the problem of global warming cannot be solved by one discipline alone; we need a multidisciplinary approach. For the short-term solution, animal breeding is not the way to go – but for the long-term, it can generate permanent and cumulative changes in the performance of animals – if you don't change the genetic background of an animal, you will have to use the same practice in 10 years as you are today. If you select on certain

traits, you can improve the genotype, and with that get more out of your animals. I think to achieve this several disciplines should go hand in hand.

Can you describe the Methane Physiology for Geneticists course that you are planning in Dummerstorf, Germany, in September 2014? What will it involve and what do you hope that it will achieve?

This course is mainly important to stimulate conversation in the 'same language'. Animal geneticists think differently about a trait or phenotype than animal physiologists do. This sometimes creates misunderstanding and I believe that everyone can benefit from each other. For a geneticist, a phenotype does not necessarily have to be 100 per cent accurate, as long as it can be easily and cheaply recorded on many (>25,000) animals. For a physiologist, a phenotype that is not 100 per cent accurate might not be worth anything at all. We will try to figure this out, and open a discussion so that we can learn from each other. It could be that geneticists make too many shortcuts – or physiologists focus too much on the little details for the purpose of genetic improvement.



The flatulent menace

A group of scientists at **Wageningen UR Livestock Research** in The Netherlands is investigating the damage being done by greenhouse gas emissions from cows and has recently become the centre of METHAGENE, a Europe-wide collaborative network to help resolve this issue

IT IS A widely known fact that anthropogenic greenhouse gases (GHGs) such as CO₂ are a threat to the environment, on the basis that they encourage global warming. In fact, some GHGs are not anthropogenic in the fullest sense of the word – ruminant livestock, including cows, excrete large volumes of GHGs, including methane, which is 25 times more detrimental to the environment than CO₂. Perhaps surprisingly, this kind of emission makes up a relatively large proportion of total anthropogenic GHG emissions; some sources suggest that a cow might emit a comparable amount of GHG in one day to a car.

The reason that ruminants such as cattle produce so much methane is because of the way they digest grass. Although it is plentiful, grass holds very little nutritional value, and is difficult to process – which is why most animals, including humans, cannot eat it. The productive relationship between cows and humans, which has existed since prehistory, is based on the fact that cows can convert inedible grass into the high-quality proteins that are the basis of foods such as milk and beef. This is in stark contrast to other types of livestock, such as pigs and poultry, which consume valuable protein that could otherwise be used by humans. The ruminants are the only group of animals that can provide such an important conversion, and they would be unable to do so without the specially adapted bacteria they carry in their guts. Unfortunately,

while aiding in digestion, these microorganisms also produce methane as a waste gas.

MAKING METHANE

Considering cows as a source of pollution may seem strange – or even amusing – but under closer examination, it becomes far more serious. Humans are reliant on cattle for sustenance in the form of milk and beef, and cattle are reliant on their methane-belching bacteria. There are 1.5 billion cows in the world and they present a threat to the environment that is not easily remedied. The best route towards mitigating the pollution would most likely involve improved management practices and selective breeding – but it is hard to decide where to begin, since little is known about how much waste individual cows produce. Although we appreciate that cows as a collective are producing large quantities of

methane, detecting and monitoring the gas excreted by an individual is much more difficult than one might first imagine.

Dr Yvette de Haas has worked for many years towards improving the traits of cattle by selective breeding but, in order to make more environmentally friendly and feed-efficient cattle, she has turned her attention toward the precise measurement of an individual's methane output. In a raft of related projects, she leads a team of researchers at Wageningen UR Livestock Research in The Netherlands that has made great progress towards achieving this goal.

THE CREAM OF THE CROP

The research pursued by de Haas' group focuses primarily on using genetics to improve resource efficiency – a goal that would benefit the farmer, whose feed costs could be lessened, as well as the agricultural sector, which could see emissions reduced. Towards this end, the Dutch scientists are engaged in three related projects aimed at launching breeding values for feed efficiency in dairy cattle; determining, through life cycle analyses, the impact of selective animal breeding on the entire production chain; and measuring the individual methane emissions of dairy cows. The ultimate goal of this work is that, within a few years, Dutch farmers will be able to select parents for breeding that produce more efficient offspring.

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INTELLIGENCE

METHAGENE

LARGE-SCALE METHANE MEASUREMENTS ON INDIVIDUAL RUMINANTS FOR GENETIC EVALUATIONS

OBJECTIVES

To discuss and agree on 1) protocols to harmonise large-scale methane measurements using different techniques; 2) easy to record proxies for methane emissions to be used for genetic evaluations; and 3) approaches for incorporating methane emissions into national breeding strategies; to maximise the impact of genetic technologies for managing livestock methane emissions.

KEY COLLABORATORS

Dr Jan Lassen (Vice Chair METHAGENE), Aarhus University, Denmark • **Dr Björn Kuhla**, Leibniz Institute for Farm Animal Biology, Germany • **Professor Phil Garnsworthy**, University of Nottingham, UK • **Dr Enyew Negussie**, MTT Agrifood Research, Finland • **Dr Eileen Wall**, Scottish Rural College, UK • **Ir Marjolein Neuteboom**, European Forum of Farm Animal Breeders (EFFAB), The Netherlands

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YVETTE DE HAAS holds a PhD in Animal Genetics from Wageningen University and is currently appointed as Senior Scientist and Project Leader at the Animal Breeding and Genomics Centre of Wageningen UR Livestock Research, The Netherlands. Her research interests include genetics of dairy cattle, improving resource efficiency and international collaboration.



Goals of METHAGENE

Discuss, agree and disseminate:

- The factors contributing to variance in methane production between animals
- The use of common units to make data compatible
- The establishment of protocols for comparing and merging large-scale methane measurements
- The identity of indicator traits for methane production
- The development of tools and best practices for EU countries incorporating methane output into national breeding strategies



“The genetic improvement of livestock is a particularly cost-effective technology, producing permanent and cumulative changes in performance,” states de Haas.

Within the methane measurement project, the primary objective is to measure individual methane output using a portable Fourier transform infrared (FTIR) gas analyser. This makes it possible to take readings while the cows are visiting the concentrate feed dispenser or the milking robot; i.e. during their daily routine. This is in contrast to measurements taken in respiratory chambers, where the cow is out of its natural environment. The team is hopeful that this experimental approach will enable them to decide on the optimal measuring period for the production of an indicative reading of a cow's methane output. It is thought that this will aid in the task of unravelling the genotype that controls this trait, and link back to possible indicators that may already be recorded – such as feed intake, volumes of milk production or fatty acid composition of milk.

MEETING OF MINDS

Across Europe and worldwide, much research time is devoted to improving the management and selective breeding of cattle, especially with regard to their methane output, however, little communication goes on in this area, and there is a real risk of wasting precious research time and funding by duplicating effort. One example of this is in the measurement of methane: currently, different sources make use of different units, and the question of whether methane production (g/day), yield (g/kg dry methane intake) or intensity (g/kg edible protein) is the crucial figure, is an open one. Further hurdles to international

collaboration are presented by differences in techniques, protocols and equipment used for measurements between countries.

These problems led de Haas, in December 2013, to establish the METHAGENE network, which aims to bring together like-minded researchers across Europe to address some of the issues inherent to this area of research. In order to implement selective breeding as a mitigation strategy accurate breeding values are needed. Achieving this goal would necessitate the collection of more than 25,000 individual measurements. This endeavour cannot be tackled by one country alone, and so the establishment of METHAGENE represents a vital step towards making progress in Europe. Although it has only been running for around three months, 19 of the 35 European Cooperation in Science and Technology member states have signed up, bringing more than 30 universities and 50 scientists into the network. This is a particularly important project because some of these countries have not yet started recording methane but they will be facilitated in doing so by the experience and well-established protocols within the network.

The first meeting of the METHAGENE consortium will take place on 8 May 2014, at which time the first steps will be taken to set out and present inventories for individual methane measurement, and decide on integral research questions. Ultimately, these meetings will lead to international standards and protocols for methane measurement across the whole continent, and finally a shared database. Bringing together experts from across Europe, the project and its regular meetings will be vital in sharing knowledge and moving forward on this pressing issue.