Methane technology breakthroughs cannot stop ruminants from doing what comes naturally

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Reducing methane production from pastoral agriculture lies at the heart of efforts to make pastoral agriculture more climate friendly. If only sheep and cattle could be made to stop producing methane!

Here I look at the challenges of making this happen. Unfortunately, those challenges are not easily solved. It is a lot harder than the uninitiated might think.

This is not just an issue for farmers. It is also an issue for all New Zealanders, given that almost half our exports come from pastoral agriculture – currently more than $32 billion per annum. According to MPI, approximately 82% of all exports come from primary industries once timber, fish, horticulture and wine are included.

Without primary industries in general, but particularly pastoral agriculture, we are in very big trouble as to how to pay for all the imports of goods that we cannot produce here in Aotearoa New Zealand. Solving the methane issue would be a real big deal.

The starting point to understanding something about methane is to appreciate why ruminants produce methane. The quick answer is that it is a fundamental component

of how ruminant animals, with their distinctive four-stomach system, have been designed by nature to digest grasses.

For humans, pigs, chickens and other species with single stomachs, known in biology as 'monogastrics', it is not possible to digest grass efficiently. Accordingly, if humans try and eat a meal of grass, they will get a sore stomach and very little sustenance. Indeed, it is simply not possible for humans to survive on a grass diet.

In contrast, ruminant animals such as sheep, cattle, goats and deer have a four-stomach system, designed by nature through evolutionary processes so as to be able to digest grasses and other high-fibre forage crops that contain cellulose. The ruminants do this with the help of trillions of bacteria that live within the rumen system. These bacteria ferment the cellulose in the grass to form volatile fatty acids which can pass though into the bloodstream of the ruminant.

This process of ruminant nutrition leads to carbon dioxide and hydrogen as waste products. At this stage another group of micro-organisms called 'methanogens' come into the picture. They turn the waste products into methane, with four hydrogen atoms attached to each carbon atom. The ruminant then burps up the colourless odourless methane.

When nature first designed ruminants through evolutionary processes, there was no need to minimise greenhouse gases. These gases only became an issue once humans interfered with natural processes by digging up huge quantities of fossil fuels that had been buried for millions of years.

Modern science tells us that it is water vapour first and then carbon dioxide that are the main greenhouse gases. But methane also happens to be a greenhouse gas that absorbs infrared rays at specific wavelengths as they travel back from earth into space. So methane, which ruminants have been happily burping for millions of years without a problem, are now considered to be part of the modern greenhouse gas issue.

The problem is that nature's ruminant nutritional system was designed for a purpose over millions of years by trial and error. That is how evolution works. And nature does not necessarily take kindly when humans want to interfere with the basics of that ruminant system. Change part of the system and there is always a good chance that the overall system will fall apart.

One way or another, the excess hydrogen has to be removed from the rumen. Otherwise, the rumen will turn from a fermentation vat to an acid vat. The animal will not be impressed and will get very sick.

Accordingly, it is not just a case of killing the methanogens. Something else has to take over the job that the methanogens do naturally. If there was an easy solution

that was energetically better than producing methane, then nature would in all likelihood have figured that out itself.

So, what are the technologies that humans have been exploring?

One of the most fascinating technologies is to feed some bromoform-releasing seaweed to ruminants. These trials have been going on both in New Zealand and overseas. The bromoforms are particularly good at killing off the methanogens, but unfortunately, they tend to also mess up other parts of the rumen system. Particularly important is the finding in a recent scientific paper that bromoforms pass from the rumen into milk.

Alas, bromoforms are a suspected carcinogen and certainly have the ability to interfere with many human processes. My own assessment is that, despite some ongoing hype, there is close to zero chance of this technology being acceptable to food-safety authorities. Indeed bromoforms, which are similar in their action to chloroform, are already widely banned in foodstuffs.

The second feed additive that has generated considerable hype is a chemical called 3-NOP. This has been developed through to early-stage commerciality by Dutch firm DSM with the trade name Bovaer.

This technology appears to be much safer than bromoforms and does reduce methane production in feedlot situations for dairy and beef cattle. However, the evidence to date is that it does not work under pastoral conditions because it needs to be evenly distributed throughout the feed.

Fonterra has been working with DSM to try and develop the technology for pastoral situations. The barriers are formidable. Whispers on the breeze are that Fonterra's research has not gone well and that there are some very glum faces. At the very least it is a long way from commercialisation for pastoral conditions. Also, there are good scientific reasons as to why it is highly unlikely to ever work anywhere near as well in pastoral situations as it might do in a feedlot.

The other area of hype which has been around for the best part of two decades is a vaccine that leads to methanogen destruction. Research has shown that it is possible to get the animals to produce antibodies that travel via the saliva to the rumen, but getting the antibodies to actually work in the rumen is another matter. This technology has remained somewhere out beyond the ten-year horizon for more than a decade and commercialisation has not been getting any closer. Once again there are some glum faces.

Another technology has been genetic selection for low-methane-emitting sheep and cattle. This is definitely feasible and may be a modest success. In sheep, where the research is most advanced, the lower-emitting animals have smaller rumens and

produce more propionic acid than what occurs in the higher-emitting animals. Also, it seems these characteristics are inheritable.

However, there will be limitations to how far that technology can be taken. There are good reasons why fatty acids other than propionic acid, and which produce more methane, also have to be produced. It could be a useful tool in the toolbox but once again there is some risk that it is being overhyped. Caution is appropriate until there is more evidence as to how these animals perform under rugged pastoral conditions.

Pulling all of this evidence together, the big picture is that there are no magic technology bullets that can drastically alter the reality that ruminants emit methane for a good reason. This methane is the outcome of evolutionary processes that produce animals that are fit for the grassland environment in which they live naturally.

However, that does not mean that no progress can be made in terms of emitting less methane per unit of meat and milk output. Indeed, the last 30 years have produced an amazing but seldom told New Zealand story as to how methane emissions per kg of sheep meat have reduced by about 30%. Dairy emissions per kg of Milksolids (fat plus protein) have reduced by about 20%.

The way these spectacular efficiency improvements have been achieved is by the breeding of more productive animals and incorporating these animals within improved farming systems. Fortunately, improved biological efficiency has also led to efficiency improvements relating to methane emissions.

In the coming years there will be further improvements to be gained in relation to reduced emissions per unit of output, but it will be hard work. Each percent of gain is more challenging than the previous one.

One particularly promising field of endeavour is the methane produced in effluent ponds rather than inside the rumen. But across the all-species ruminant system, methane from effluent ponds comprises only about 4% of the total methane emissions.

None of these advances will change the bottom line that there will be no magic methane bullets. As long as ruminants live on the grasslands, they will continue to do what nature designed them to do, and that includes emitting lots of methane.

Given that reality, together with the fundamental importance of pastoral agriculture to the export-led economy, there is lots to ponder.