LIVESTOCK AND CLIMATE CHANGE

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concludes, in the second of a two-part article, his argument that livestock's impact on climate change has been underestimated – and suggests alterations to farming practices and human attitudes are urgently required

DECREASING the size of our collective ecological footprint is critical, if we are to avert the most catastrophic consequences of impending climate change. Therefore, we are increasingly urged to decrease our energy consumption. We are encouraged to use greener means of travelling, to insulate our homes and businesses, to use low-energy light bulbs and appliances, and to recycle as much as possible.

Yet a study (Goodland and Anhang, 2009) indicates that livestock production accounts for at least 51 per cent of worldwide greenhouse gas (GHG) emissions, and probably significantly more. This makes the livestock sector the single largest contributor to climate change. In contrast, the combined figure for all forms of transport is around 13.5 per cent of global GHGs.

The remarkable lack of attention afforded to livestock production to date reveals considerable societal discomfort about acknowledging the costs incurred by our preferences (these are not truly needs) for animal products. However, the inconvenient truth is that the emissions resulting from clearing land to graze livestock and grow feed – from the livestock themselves, and from processing and transporting livestock products – are greater than those resulting from any other sector.

Deforestation for pastures and feedcrops produces carbon dioxide directly. Enteric fermentation by ruminants results in methane, which exerts 72 times the global warming potential (GWP) of CO_2 over a 20-year timeframe. Manure releases nitrous oxide – which has 296 times the GWP of CO_2 – and ammonia, which acidifies rain and ecosystems.

Flatulence is only a small portion of cows' methane release. Due to the physiology of their digestive systems, cows also emit the gas through burping.

Mitigating the impacts of animal agriculture

A range of options exists, with varying potential to ameliorate the adverse environmental impacts of the livestock sector. Most useful are those that contribute to the mitigation of several GHGs simultaneously, such as aerobic digestion of manure, or those that provide other environmental benefits concurrently, such as good pasture management. Those with the greatest potential for mitigating emissions on a global scale include the following methods.

- **Reducing methane emissions**

The methane by-products of anaerobic enteric fermentation by ruminants may be decreased by increasing feed digestibility, either by feed modification or digestive manipulation.

Within developing countries or arid regions, many ruminants are maintained on highly fibrous diets, resulting in high emission levels. Additives, such as dietary fat or increased grain, would substantially improve such diets, and increased starch or rapidly fermentable carbohydrates would reduce excess hydrogen and subsequent methane formation. Unfortunately, lack of availability, capital or knowledge frequently limits the application of such strategies.

In some cases, national strategic planning could assist. In countries such as Australia, with arid and temperate farming regions, policies aimed at concentrating dairy production in the latter regions would assist, because temperate pastures are more likely to possess soluble carbohydrates and easily digestible cell-wall components, thereby decreasing emissions. The potential for efficiency gains and, therefore, methane reductions, are even greater for beef and other ruminant production, where dietary management is usually poorer. Such major structural changes are long-term processes that would require major financial investment.

In many cases, production efficiency and GHG profiles may also be improved through: grazing management; soil testing with fertilisers and other additives applied as appropriate; preventive herd health programmes; provision of adequate, clean water sources; and genetic selection for health and productivity.

Selective ruminal defaunation or vaccination (to reduce methanogens) and reduction of hydrogen production by stimulating acetogenic bacteria are some of the technologies under development.

However, successful implementation of such GHG mitigation measures not only requires technological development, but also economic incentives and policy frameworks appropriate to specific farm conditions within various regions.

Unfortunately, some of these objectives are also contradictory. For example, widespread increases in grain consumption where diets are poor would decrease methane resulting from enteric fermentation – but would considerably increase GHGs resulting from grain production, would result in a net decrease in available food (given poor ruminant conversion ratios of plant-to-animal protein), and would consequently increase grain prices and food scarcity overall.

- **Manure management**

Methane emissions from ruminant manure are considerable, and low assimilation of dietary nitrogen, at around 14 per cent, results in considerable nitrous oxide emissions. However, increasing carbon-to-nitrogen ratios within feed rations exponentially decreases methane emissions. Nitrogen assimilation can be increased by grouping animals by gender and production phase, and feeding rations with protein and amino-acid

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Jungle burned to make way for agriculture in southern Mexico.

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levels balanced and optimised to group requirements. Unfortunately, large quantities of nitrogen remain in manure, so additional strategies are necessary.

The majority of nitrous oxide emissions come from grazing systems and can be minimised by avoiding overstocking. Where animals are confined indoors, with manure collecting beneath flooring, such as on pig or poultry farms, emissions may be increased by higher ambient temperatures. Therefore, frequent manure removal in climates where outdoor temperatures are lower decreases emissions. Unfortunately, this significantly increases labour costs.

Deep cooling manure (to below 10°C) provides an alternative. Cooling pig slurry has been reported to reduce methane and nitrous oxide emissions by 21 per cent. However, such cooling requires significant financial investment. It also increases energy requirements and associated emissions.

Controlled anaerobic digestion, via bacterial fermentation in covered lagoons, pits or tanks, decreases nitrous oxide emissions. Emissions from slurry manure may be decreased by half or three-quarters in cool or warmer climates respectively. The resultant slurry applied to agricultural land has decreased emissions. Systems to capture emissions may also be used to produce biogas, which is typically 65 per cent methane and 35 per cent CO_2. This mixture can be burned directly to provide light or heat, or in modified gas boilers to run internal combustion engines or electric generators. Anaerobic digestion also decreases odour and pathogens.

Unfortunately, many of these options are limited by equipment, environmental constraints or costs. Additionally, technologies with the potential to decrease nitrous oxide emissions often increase methane emissions, and vice versa.

Land management

Carbon released from land use changes and degradation dwarfs emissions from other sources. The greatest contributor is deforestation, particularly in the Amazon, where vast swathes of land are cleared daily for pasture or feed crop production. Therefore, reduction of deforestation is critical, and requires a range of policy measures, including economic incentives and alternatives for farmers. Using conventional agricultural techniques, the conversion of such natural systems to cultivated lands results in soil organic carbon (SOC) losses of between 20 to 50 per cent in the shallowest metre of earth.

Historic SOC losses are massive, at between 42 billion tonnes and 79 billion tonnes worldwide. However, adopting improved practices on 60 per cent of worldwide arable land would allow carbon sequestration at a rate of 0.3 tonnes of carbon per hectare annually, or a total of 270 million tonnes annually for the next several decades. After that, it appears carbon acquisition may slow. Nevertheless, the carbon sink capacity of the world's agricultural and degraded soils has been estimated at between 50 and 66 per cent of total historic SOC losses.

Nitrogen fertiliser is applied to growing corn (maize) in Iowa.

The improved practices necessary include crop intensification, conservation and erosion reduction. Crop intensification may be achieved via the use of higher-yielding, better-adapted cultivars, irrigation, fertilisation, soil acidity management, integrated pest management, double or triple cropping (where possible) and crop rotations that include "green manure" or cover crops. Aside from increased productivity, decreasing land use requirements and deforestation, beneficial outcomes would include greater carbon accumulation within crop biomass, higher crop residues and greater subsequent storage within soil.

Significant emissions are accrued from fertiliser production and distribution. However, gains in carbon sequestration and land use efficiency – particularly if deforestation can be avoided, or land can be released for forest regrowth – far exceed the cost. Fertiliser production and transportation emissions may also be decreased if manure slurry produced locally is recycled after biogas minimisation and capture. Local production similarly decreases emissions associated with livestock transportation, as well as animal welfare problems.

Nitrogenous emissions from slurry applied to crop land may be decreased by, for example: using nitrification inhibitors that target nitrous oxide emissions; shallow or deep injection into soil; application close to the time of optimal crop uptake; decreasing soil moisture through improved drainage; and preventing soil compaction by traffic, tillage or livestock.

As previously stated, overstocking, with subsequent soil degradation and increased emissions directly from livestock and its manure, must be avoided.

Conservation tillage refers to any system where 30 per cent or more of the crop residue remains on the surface. Such systems also reduce mechanical disturbance during cropping. Although originally developed to address water quality problems, soil erosion and agricultural sustainability, other benefits include improved fuel efficiency and decreased associated emissions, due to decreased machinery use. Most importantly, the Intergovernmental Panel on Climate Change (IPCC) has estimated that conservation tillage can sequester between 0.1 tonnes of carbon per hectare per year and 1.3 tonnes of carbon per hectare per year globally, and could feasibly be adopted on 60 per cent of arable land.

Silvopastoral systems involve planting widely-spaced trees within grazed pastures. They may sequester significant carbon, stabilise soils, decrease degradation and provide livestock with shelter.

Changing human consumption patterns

The Earth's population is expected to increase from 6.8 billion people to nine billion by 2040. Approximately three billion of those are increasingly affluent, developing-world consumers enthusiastically attempting to emulate the consumptive lifestyles of richer nations by, in part, consuming more animal products. Accordingly, the Food and Agriculture Organisation of the United Nations predicts that global meat consumption will more than double from 229 million tonnes in 1999/2001, to 465 million tonnes in 2050. Milk consumption is expected to rise from 580 million tonnes to 1,043 million tonnes.

This leads to the conclusion that "the environmental impact per unit of livestock production must be cut by half, just to avoid increasing the level of damage beyond its present level" (Steinfeld et al, 2006). Furthermore, significant reductions in present levels are also necessary to avoid catastrophic climate change. Therefore, mitigating the emissions resulting from our existing patterns of consumption will be far from sufficient. Considerable changes in consumption will also be required.

Ruminants versus monogastrics

One option is to consider alternative sources of animal protein. The feed conversion efficiency of different species varies widely. For every kilogram of live weight gain, an average of 7kg of feed is required for feedlot cattle; 3kg for pork; slightly more than 2kg for poultry; and less than 2kg for herbivorous species of farmed fish, such as carp, tilapia and catfish. Therefore, herbivorous aquaculture offers marked efficiency gains.

However, the benefits are much less clear in the case of carnivorous fish, such as salmon or shrimp. The former are less efficient than herbivorous fish because they must be fed other fish, whereas the latter often involve the destruction of

Lucky country's marsupial metaphors

"STREWTH, them cockatoos – they'se so bloody raucous 'n' loud, with all that yabber you'd think they'se bickering 'bout whose bloody shout it is! 'N' would youse believe it – even the bloody blowies are 'ready up 'n' about! Eh, g'day mate, didn't see youse there! Name's Bruce. Haw's it gawin'?"

NIGEL DOUGHERTY
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takes us on a wildlife odyssey in the land down under, and wonders which of the myriad species of unique and wonderful inhabitants best represents the personality of modern-day Australia – and which might fall by the wayside

Stereotypical

So, here I was, in the company of "Bruce" – Bruce being a pseudonym, of course, and one that immediately conjures up that stereotypical perception people seem to have of the Aussie bloke. But, whatever you do, don't knock Bruce; the likes of him are the ones who actually do the hard yakka in the bakka beyond – and it's that hard yakka that actually makes Australia's economic wheels go round.

"Now, by tha looksa things, youse a jackaroo 'round these paatz, I reck'n. So, what bringsya to this forsaken parta th' back a bourke? Come to find out what's dinkum about life down under? Well, youse first betta learn a bitta 'Strine."

But Bruce surmised wrongly about the jackaroo intentions. I hadn't specifically ventured into the outback to help him brand his cattle and dag his bloody jumbucks. I'd simply always longed to encounter a few of those real ridgie-didge Aussie "bewdies"– the likes of wallabies, kangaroos and wombats – and, above all else, the prospect of seeing a wild "billy bluegum": the koala.

But while watching some of Australia's wildlife personalities, I began to see those very characteristics shining through and into what might have shaped and inspired some of the country's human stereotypes. As a result, my visit soon moved beyond wildlife odyssey and into a wider musing about things Australian.

Belonging

The likes of people such as Bruce have taught me the basics for understanding why things tick the way they do in the land down under. Above all, I have learned that Australia may be a stiflingly hot and dusty place in which to farm, but Australia means everything to every Australian. The land down under, you see, is the lucky country; whether you're talking about one of those bowerbirds living it up in town, or the down-to-earth outback folk eking a living from little more than dust, they all have an equally strong sense that they belong.

Fundamental to setting all the Aussie rules is the fact that, as a continent, she's so extremely old – to all intents, she is primordial. Her ancient geology seems to have been the biggest influence in carving her living cargo into such an energy-saving bunch. It is this part of her nature that has really shaped all those rough, tough – yet down-to-earth – characters.

The ancient geology of Australia has influenced its fauna's energy-saving characteristics.

continued overleaf

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coastal mangrove forests to create shrimp farms.

Farming fish and shrimp in offshore ponds may also concentrate waste, contributing to eutrophication and dead zone creation. The high stocking densities and space limitations of fish farms also create significant welfare problems, which parallel those of intensively farmed land animals.

Decreasing consumption of animal products

For those of us in richer nations, a significant decrease in our present overconsumption of animal products is urgently required. Marked disparities exist in consumption patterns internationally. The annual two billion tonne global grain harvest would support 2.5 billion people consuming as much animal protein as Americans, five billion people consuming as much as Italians, and 10 billion people consuming as much as Indians – which is to say, hardly any animal protein.

Among these three countries, life expectancy is highest in Italy, despite much higher US medical expenditures per person. People who live very low or very high on the food chain do not live as long as those at a more intermediate level. Those of us in wealthy nations consuming high levels of animal products can significantly improve our own health and longevity – as well as the planet's – by consuming less animal products. The average British citizen consumes 50g of meat-based protein daily – between 25 and 50 per cent more than the level recommended by the World Health Organisation.

In its 2001 report on climate change mitigation options, the IPCC stated that "a shift from meat towards plant production for human food purposes, where feasible, could increase energy efficiency and decrease GHG emissions".

When receiving the Nobel Peace Prize for the IPCC's work in 2007, its head Rajendra Pachauri asked the world to "please eat less meat," and has since repeated and strengthened this call. Of course dairy – and, to a lesser degree, egg – production also incur marked environmental costs.

Additionally, they frequently incur severe welfare costs, particularly in the case of caged laying hens. It has also been concluded that replacing livestock products with alternatives would be the best strategy for reversing climate change (Goodland and Anhang, 2009). The implementation of such a policy would have far more rapid effects on GHG emissions than livestock emission mitigation or, indeed, the replacement of fossil fuels by renewable energy sources.

Of all available options, decreasing the consumption of livestock products would bring the most immediate benefits, for the lowest cost, and would not require the development of any new technologies.

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