Animal production and the "greenhouse gases".

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ABSTRACT

Attention is drawn to developments in the public perception of animal farming which have the potential to adversely affect the animal industry in the future. These developments, which are occurring around the world, stem from review of ethical aspects of animal farming and from concern at the ecological impact of animal farming. Of particular concern is the emission of greenhouse gases - especially methane - by ruminants. This paper discusses measures by which these emissions could be reduced, and how national policy decisions regarding greenhouse gas emissions on farms may be reached. Opportunities for this Society are pointed out.

Keywords Ethics; future of ruminant farming; greenhouse gases; methane; ruminant methanogenesis.

INTRODUCTION

The future of animal production in New Zealand has been a topic of discussion throughout the 50 years of this Society's existence. Speakers such as Levy (1951), Hamilton (1954), Stitchbury (1965), Everitt (1973) and Rattray (1981) have forecast the glittering prizes to be attained by working harder or by adopting new strategies, or new technology, or new strains or species of animals and plants. There have been moments of gloom, but overall the messages have been optimistic: and throughout there have been the assumptions that animal production as we know it, like the sun and the stars, will continue to exist into the foreseeable future and beyond, and that there will always be a demand for our animal products.

The purpose of this paper is to draw attention to developing threats to such comfortable assumptions. The animal industry has been under pressure before, from low profitability, shrinking red meat markets, competition from synthetic materials - essentially "market forces" of the kind beloved by our politicians. The new threats are pressures of a different kind, arising from changes in the public perception of animal farming in general and of ruminant farming in particular. Their sources are philosophical and ecological - the ethical acceptability of farming animals, and the anticipated harmful effects of "greenhouse gases" produced during animal farming. Those changing perceptions have the potential eventually to cause major disruption to the animal industry: they must therefore be taken seriously, their bases must be understood, and rational and enlightened responses must be developed.

Ethical arguments

The ethical acceptability of animal farming - the ethical rightness or wrongness of animal farming and the practices it involves - is under review around the world. Opinions vary widely, from acceptance of the *status quo* to the view that it is no longer acceptable for humans to exploit animals for human purposes. Proponents of the latter opinion argue that such exploitation, animal farming included, is a form of "speciesism" that infringes the "rights" of animals. The most extreme champions of this view are the "animal liberationists". Others accept animal farming but are concerned about the humane treatment of production animals. These arguments will not be considered further here : a good introduction to the cases for and against animal farming is given in White (1988).

Environmental arguments

There is widespread disquiet at the rising concentrations of the so-called "greenhouse gases" - principally carbon dioxide (CO_2), methane (CH_4), nitrous oxide

TABLE 1 Estimated Output of Greenhouse Gases, New Zealand 1989 [a]

Gas	Emission (tonnes x 10^6)	Relative effectiveness[b]	CO_2 equivalent[c] (tonnes x 10^6)	Proportion of total N.Z. contribution[d] (%)
CO_2	26.2	1	26.0	43
CH_4	1.6	9	14.0	23
N_2O	0.045	190	9.0	15
CFC-11	0.001	1500	1.5	2
CFC-12	0.001	4500	4.5	7
Others				>10

[a] Based on data from MFM (1990b).

[b] Calculated effectiveness of 1 kg of each gas relative to 1 kg CO_2, in terms of global warming potential through the next 500 years.

[c] Emission x relative effectiveness.

[d] 100% = sum of CO_2 equivalents = 60 million tonnes.

($N_2$0), chlorofluorocarbons (CFCs) - in the atmosphere. The predicted consequences in terms of degradation of the environment are serious - global warming, resulting in marked changes in weather patterns and a rise in mean sea level, and reduction in the ozone layer in the upper atmosphere, resulting in reduced protection from solar ultraviolet rays. These matters have been the subject of international meetings, international research programmes (e.g. RSNZ, 1990), comment in the science press (e.g. Pearce, 1989; Enting, 1990; White, 1990), and many scientific papers. Here, the Government has set up the New Zealand Climate Change Programme with three working groups respectively looking at facts, impacts and response policy (Hickman, *et al.*, 1989; MFE, 1990a,b). Of the culprit gases, CO_2 is produced in the greatest amounts (Table 1) but CH_4 causes more concern because it is accumulating at a faster rate than CO_2, it is several times more "effective" as a greenhouse gas than CO_2 (Table 1; Enting, 1990), and as well as contibuting to global warming, it also contributes to ozone depletion. Other gases such as N_2O are produced in much smaller amounts but make a significant contribution because they are many more times effective than either CO_2 or CH_4.

Animal farming produces CO_2, CH_4 and N_2O both directly and indirectly. Carbon dioxide is produced by all animals during normal tissue metabolism, both CO_2 and CH_4 are produced as endproducts of microbial fermentation in the gut, and N_2O is produced when urinary nitrogenous compounds are broken down by soil microorganisms. As well greenhouse gases are produced by activities associated with animal farming, such as ensiling feed, ponding effluent, using nitrogenous fertilisers, using fossil fuel for energy.

At the moment, most attention is being focused on CH_4. Our livestock are estimated to generate 1.16 million tonnes of CH_4 a year - about 72.5% of New Zealand's total emission of the gas (Table 2). Those figures compare with a worldwide livestock CH_4 production of the order of 76 million tonnes/y, some 18% of the total global CH_4 emission. The greatest part of the livestock CH_4 production is contributed by ruminants: Lassey *et al.* (1990) quote figures indicating the global production by ruminants to be about 70 million tonnes/yr. Further, ruminants produce more CH_4 per unit of energy intake than do other farmed animals such as pigs, chickens and rabbits (Blaxter,1962).

The perception that ruminants are ecologically "dirty" animals is attracting adherents, particularly in "green" movements. If it were to become the general

TABLE 2 Estimated Methane Emissions (million tonnes/y)[a]

Source	Global Emission[b]	NZ Emission
Livestock	76 (65-87)	1.16 (0.9-1.4)
Termites	9 (32-42)	[c]
Natural wetlands	80 (40-160)	0.08 (0.04-0.16)
Rice paddies	92 (60-140)	0
Landfills	50 (30-70)	0.3 (0,2-0.5)
Biomass burning	37 (12-110)	0.003 (<0.009)
Hydrocarbon fields	41 (30-55)	0.015 (0,007-0.023)
Coal mining	35 (25-45)	0.016 (0,008-0.024)
Thermal waters	[c]	0.001 (<0.005)
Methyl hydrates	≈0	[c]
Oceans	3 (1-7)	[c]
Totals	≈423 (300-700)	≈1.6 (1.2-2.1)

[a] Data from Tables 3 and 7 in Lassey *et al.*, (1990). Best estimates, ranges of estimates in brackets.

[b] As pointed out by the authors (Lassey *et al.*, 1990), the figures are based on limited information and include many, often large, uncertainties.

[c] Insufficient data to estimate emission; probably minor sources.

opinion in New Zealand or in the communities where we market our animal products, ruminant farming could face public disapproval and economic sanction.

REDUCING RUMINANT METHANOGENESIS

Can we reduce methane production by ruminants? There are four obvious measures we might take to reduce methanogenesis associated with animal farming:

- stop farming animals,
- farm fewer ruminants,
- farm animals that produce less CH_4,
- reduce the amount of CH_4 produced per unit of product.

To stop animal farming would not be acceptable for cultural or economic reasons in many parts of the world, including New Zealand.

Farming "low CH_4" species such as pigs, rabbits and chickens could certainly provide food as well as some of the other products ruminants at present supply e.g. leather. However, there are limitations to this solution, including religious restrictions, less efficient utilisation of plant fibre, and competition with humans for food.

Reducing the CH_4 : product ratio is a more attractive possibility. Methane production is characteristic of anaerobic fermentations and in ruminants represents an irreversible loss of dietary energy of the order of 8% (Blaxter, 1962) but may be as high as 15% (Preston and Leng, 1989). Attempts to reduce that loss have identified two useful avenues, modifying the diet, and modifying the microbial activity. Thus N supplementation _of poor quality diets such as straw can improve the digestibility of the diet and reduce CH_4 production (Preston and Leng, 1989). A range of susbstances can modify microbial CH_4 production, including halogenated methane analogues (carbon tetrachloride, CCl_4, is very effective but too toxic for practical use), sulphated fatty acids (detergents), carboxylic acids, and nitrates (Czerkawski, 1969; Chalupa, 1980). The most promising modifiers appear

to be the ionophore antibiotics such as monensin, lasalocid, and tetronasin. Monensin is used commercially as a feed additive to control coccidiosis and, in intra-ruminal depots, for bloat prevention in cattle. As well as reducing methane loss, the ionophores improve the efficiency of utilisation of feed in other ways : acetate production is decreased and propionate increased, while ammonia production is decreased and N retention is improved (Chalupa, 1980).

Breeding animals for low methanogenesis may be a fifth, long-term, measure. This possibility is suggested by individual animal variation in CH_4 production (eg, Murray *et al.*, 1976) and in responses to treatments.

Searching for practical solutions

A discussion paper (MFE 1990b) on the options for New Zealand was published in May1990 by the New Zealand Climate Change Programme group studying possible responses to climate change. It considers strategies for both limitation (reducing greenhouse gas emission) and adaptation (adapting to environmental change), with the aim of evolving national policy. Among the many possibilities it considers is a charge on greenhouse gas emissions, a kind of "polluter pays" tax. This is recognised to be an unreliable means of controlling greenhouse gas production, difficult to apply evenly in practice, and likely to increase the costs of goods and services to the consumer. As a solution, unfortunately, it has that simplistic logic that bureaucrats do not seem able to resist. The implications and inadequacies of taxation to control CO_2 emissions are discussed by Helm (1990).

Any suggestion that ruminant farming in New Zealand should be curbed would undoubtedly be strongly resisted. "Why pick on New Zealand? The amounts of greenhouse gases we produce are small and insignificant compared with the amounts produced in the northern hemisphere." New Zealand is indeed a small player in global terms, accounting for only some 0.5% of world emissions of CO_2 and CH_4. Further, CH_4 production is not confined to ruminant farming - there are other large sources such as wetlands and landfills (Table 2). Proposals to limit methane production must take these other sources into account also. Clearly, effective action calls for a co-ordinated approach at both national and international levels.

Measures for reducing greenhouse gas emissions in animal farming under tropical conditions in South America have been discussed by Preston and Leng (1989). They advocate a system "emphasising CO_2 fixing crops (sugar cane and trees), meat production from monogastric animals using local resources, simple biogas technology, and use of biomass as combined sources of feed and fuel, thus reducing dependency on fossil fuel" (Preston and Leng, 1989). Using such a system on a highly integrated small (2ha) farm in Colombia, 2880 kg/yr of pigmeat and 325 kg/yr of sheepmeat were produced for a calculated average emission of 0.058kg CH_4/kg meat, compared with a calculated emission of 0.80 kg CH_4/kg meat for a steer grazing unsupplemented tropical pasture to a slaughter weight of 450 kg (225 kg meat) reached in 4 years.

The intensity of integration of the Colombian farm would not be practical on the average present day farm in this country. However the principles described by Preston and Leng (1989) are logical. Embodied in measures adapted to a temperate ecosystem, they could well form the basis for designing new animal farming systems emitting less greenhouse gas/unit product than our conventional systems. Further reductions of ruminant methanogenesis could be gained by dosing the animals with ionophores.

The choice of action or actions to be taken will, of course, depend on the target limits set nationally and internationally for greenhouse gas emissions by animal farming. Whatever those limits may be, viable methods of control will depend on detailed, quantitative knowledge of the emissions and the effects of prospective control measures. Research into the emissions by ruminants is particularly important to New Zealand. It must be carried out in our farming environment, it must include both CO_2 and CH_4, and it must involve actual measurement rather than estimation of outputs.

REACHING DECISIONS ABOUT METHANE AND ANIMAL FARMING

How will decisions be reached in New Zealand?

Major decisions aimed at reducing greenhouse gas emissions in New Zealand will inevitably have

complex and far-reaching effects nationally. They will also involve international consultation and, hopefully, international collaboration. The decisions will therefore have to be made by Government and formulated in new legislation. The Government will be advised by the Ministry for the Environment and the working parties of the New Zealand Climate Change Programme. Normally, there would be opportunity for submissions when the proposed legislation is being considered by a Select Committee.

Ideally, decisions about ruminant farming should not be made in isolation. What actually happens, however, is likely to depend on the strength of public opinion. Ruminant farming is generally accepted by the public as part of the New Zealand way of life. However, pressure against ruminant farming could escalate rapidly if an incident kindling public fears of real or perceived effects of greenhouse gases were to be exploited by militant political groups. The Government might then be forced into making a premature decision on ruminant farming, out of context and without adequate consultation and discussion. Discussion *is* needed because not only are there complex technical and social problems, but there are also ethical problems. Ethical analysis is needed to answer difficult questions such as "What are the rights of an individual person (or nation) to choose and pursue a particular course of action, eg clearing a forest, versus the rights of the rest of the community (or nations of the world)?" or "What responsibility has New Zealand, as a very small contributor of greenhouse gases, to undertake emission control measures which could disadvantage our economy?" Questions like these must be addressed honestly if lasting solutions are to be found

The role of the Society

In matters of public concern where sound decisions require input of scientific data, it is clearly the duty of scientists to provide the needed data, to provide appropriate analysis of the data, and to ensure that the users fully understand the basis of the analysis and the limitations of both the data and the information derived from them. Such is the case with the decisions which will be needed in working out national strategies for limiting the greenhouse gas emissions caused by animal farming. The New Zealand Society of Animal Production is ideally placed to provide the science inputs for those decisions. We should actively prepare for that advisory role by discussing the ethical, scientific and practical issues amongst ourselves and with others whose special knowledge and experience are likely to help. Involvement in solving the greenhouse gas problem would create an important opportunity for the Society to provide leadership for the animal farming industry and for the scientists and technologists that serve it. The Society would also have the opportunity to enhance its standing with the public by identifying closely with the changing animal industry and by gaining recognition as an authoritative source of wise counsel regarding animal farming.

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