A road map for the beef industry to meet the challenge of climate change—A discussion document

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Background and Introduction

The first issue of Animal Frontiers focused on the role of animal agriculture in the carbon economy, from the production of animals to their marketing (farm to fork; Zinn, 2011). Capper (2011) emphasized that analysis of the carbon footprint needs to be evaluated per unit of meat or milk produced for a given period of time rather than per animal unit, regardless of the quantity of product produced or the time required to produce that product. Increasing efficiency of production per animal and per national herd reduces the impact of livestock production on the carbon footprint. Hermansen and Kristensen (2011) agreed that reduced total feed use per kilogram of product produced (increased efficiency) is important as a mitigation measure, but pointed out that the carbon footprint of different feeds is affected by growing conditions including soil carbon sequestration. Similarly, alternate land and manure use and distribution are also important components to complete life cycle analysis of various production systems (Figure 1) for livestock. Ledgard et al. (2011) reported that in lamb systems, 80% of emissions arise from the farm (mainly animal methane and nitrous oxide emissions), 3% from processing, 5% from all transportation stages (predominantly from shipping), and 12% from retailer/consumer/waste stages (dominated by retail storage and home cooking). Moran and Wall (2011) considered several broad issues that underpin efficient policy on managing livestock emissions, and Gerber et al. (2011) recently examined policy options in addressing the contribution of livestock to climate change.

This paper concentrates on the beef industry and proposes practical measures that the industry can take to meet the challenges presented by climate change. The background to the resulting recommendations is contained in a paper (Scollan et al., 2010) commissioned by the International Meat Secretariat (http://www.meat-ims.org).

The Challenge

The beef industry is clearly a very important and dynamic part of the agricultural economy, and the increasing global demand for meat products presents opportunities but also several challenges for the industry. See also in this issue the papers of Hocquette and Chattelier (2011) and Bell et al. (2011).

Specifically, these challenges are

- the need to continue to deliver productivity (efficiency) gains, particularly in countries predicted to account for much of future growth,
- ensuring food security and meeting market needs,
- ensuring rural livelihoods,
- improving environmental sustainability, and
- managing animal and human health risks.

Addressing these challenges will help the beef industry continue to play an important role in global agriculture. But as Gill et al. (2010) pointed out, the policy community has difficult decisions to make in balancing, for example, the potential negative contribution of livestock to climate change against the positive benefit in terms of food security and rural livelihoods.

Key Actions

As countries enact policies to curb greenhouse gas (GHG) emissions, the livestock sector will be a key component of these policy strategies. The extent of the problem in relation to beef systems has been highlighted by de Vries and de Boer (2010). They calculated from the literature that emissions from beef systems range from 14 to 32 kg CO2 equivalents per kilogram of product (mainly associated with the range in land requirement), far greater than pork (4 to 10 kg) and poultry (4 to 7 kg). It is essential that the industry engages closely with policy makers and other stakeholders to solve problems and to emphasize the multiple roles of beef cattle in maintaining landscape and biodiversity, food security, and livelihoods, particularly of the poor.

Standardization of Methodology

Estimates of GHG emissions are characterized by much uncertainty. Decisions need to be based on sound estimates. It is therefore important that the industry supports the development and use of more precise methods to calculate national inventories and the extension of inventories to developing countries not currently signatories to emissions reduction obligations. In the same way the industry should press for standardization of life cycle analysis methodology to overcome the confusion that currently exists (Bertrand and Barnett, 2011).

Animal Disease

It is now widely accepted that animal disease control measures can be an effective strategy for GHG control. Sick animals are basically less productive, leading to greater emissions per unit of animal product. Many
countries have national strategies for control and surveillance, but there has been little attempt to quantify emissions co-benefits. This is a potential area of work where the industry could take a lead.

**Mitigation of Emissions**

The livestock industry has large potential to contribute to climate change mitigation (Gerber et al., 2010). The beef industry should work with relevant stakeholders to help realize this potential. This must occur at national and international levels and should include enhancing capabilities to monitor and report emissions from livestock production (Figure 2). Effective knowledge transfer is vital to ensure that mitigation technologies are delivered and then employed by livestock producers (and other key players across the meat-supply chain). This is particularly important in developing countries.

The beef sector is characterized by a variety of production practices that offer the potential for low cost mitigation (i.e., GHG reduction). Indeed there is considerable scope for improvements in productivity that deliver win-wins in terms of reduced production costs and decreased emissions. It is important for the sector to identify these measures and for them to become best practice. In this respect, the industry should actively promote these solutions to its members. Beef industry organizations should consider joining the project on Mitigation of Climate Change in Agriculture (MICCA; http://www.fao.org/climatechange/micca/en/) to help achieve these objectives. Mitigation strategies must target on the key areas, and these differ according to production system. In beef systems, the main problems are methane, emissions associated with land use, and the uncertain role of carbon sequestration in grazing systems (Soussana et al., 2010).

The main methods for emission reduction that have been developed and are or may be implemented immediately include the following:

- increasing productivity per animal by improving nutrition and use of improved genetics, though the response may not be linear;
- increasing fertility to reduce number of followers required (both of these first two options are based on improving production traits through genetic improvement);
- improving the health and disease status of animals to increase longevity, reduce turnover rate (thereby reducing the number of followers required), and ensure that animals are producing as efficiently as possible; and
- more efficient manure and fertilizer management.

Improving production efficiency on farm is an important route to reducing GHG emissions. This is potentially a win-win situation and must be actively promoted. The livestock industry has made large gains in production efficiency over the last 50 years concomitantly delivering reductions in GHG emissions. But these gains have been primarily in the pig and poultry (and dairy) sectors with relatively little progress at a global level in the beef sector. There are, however, examples of highly efficient systems that can be used as templates for development.

Actions to improve efficiency and reduce waste at the processing, transportation, and consumer stages collectively must also be actively pursued, but it must be recognized that most GHG emissions occur at the farm level.

**International Action**

The livestock industry has both positive and negative effects on social, environmental, and public health targets. Given the significance of the livestock sector to agriculture as a whole, the industry through bodies such as the International Meat Secretariat should play a leading role in securing an international framework for development of the livestock sector with a major focus on sustainability. In this respect it will be important to recognize that much of the future growth in the industry will be in transition and in developing countries. The industry needs to ensure that this growth is achieved primarily through increased efficiency rather than through an increased number of animals.

**Research and Development Implications**

It is essential that research and development are urgently pursued to deliver effective novel mitigation strategies. A considerable amount of government and privately funded research and development is focused on the delivery of low-emission livestock systems. These include the development of alternative feeds, vaccines, food additives, selective breeding, and genetic manipulation of the animal. Much of this research is focused on multiple objectives (i.e., avoiding loss of yield) and the use of innovation and research and development policy. Recently the European Union
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has supported major projects such as AnimalChange (http://www.animalchange.eu) to deliver these strategies in support of national and international programs. This program will actively involve stakeholders such as the International Meat Secretariat in the research and development and dissemination activities. The beef industry should also encourage their representative organizations at the country level to input into the program of The Global Research Alliance on Agricultural Greenhouse Gases. This will ensure that livestock emissions have a central place in the Alliance’s work program.

Key Issues

Some of the key issues that need to be answered through research are as follows:

- How can the sector make the transition to progressively stringent emissions reduction requirements?
- Understanding product life-cycle emissions beyond the farm gate.
- Understanding how the industry might function within a more general carbon pricing and trading regimen.
- How can we best adapt to a global warming of 2 or 4°C?
- How can we avoid undesirable side effects of mitigation measures on the adaptive capacity of livestock systems to climate change?
- How can we avoid undesirable side effects of adaptation measures on net GHG emissions of the livestock sector?
- What is the climate change vulnerability of the livestock sector under baseline and stabilization scenarios, both in terms of production losses and increased GHG emissions and in terms of socio-economic vulnerability, especially for smallholders and pastoralists in developing regions?

Emissions

Key future areas of research on emission reduction technologies are the following:

- Novel forages to reduce nitrogen and carbon excretion from the animal, the use of grass legume mixtures to optimize symbiotically fixed nitrogen, and reduced use of inorganic nitrogen fertilizers in pasture-based systems.
- For intensive animal production systems: 1) improved manure management, and 2) use of dietary additives in ruminant diets.
- Understanding the factors influencing carbon sequestration (Soussana et al., 2010) and deriving an operational carbon methodology for grassland carbon sequestration as affected by land management and land use will need to be developed.
- Understanding rumen microbial populations in relation to variations in CH₄ emissions.
- Identifying novel mitigation strategies, including for enteric CH₄, the role of animal genetics, immunological control, novel feeds and for N₂O, the use of nitrification inhibitors.

Adaptation

Adaptation technologies are under-researched in comparison with mitigation options. Priorities are as follows:

- adaptation of sown grasslands by increased use of species-rich mixtures, legumes, and adapted forage species and cultivars (Figure 3);
- adaptation of permanent pasture management by changes in grazing frequency to favor the maintenance of high-digestibility species and to increase tolerance to drought stress;
- adaptation by the use of intercropping with legumes and the use of C₃ and C₄ species of feed crop mixes (e.g., sorghum versus corn); and
- integrated control options to reduce the spread and impacts of gastrointestinal parasites, especially in tropical ruminant production systems.

Policy Aims

Gerber et al. (2010) described the “tragedy of the commons” that characterizes the problem of global warming and concluded that this can only be addressed through international collective action. Given that most of the expected growth in GHG emissions from livestock will occur in non-Annex 1 (developing) countries, new climate policies must provide incentives for these countries to participate.

The key policy actions should be as follows:

- deriving the most promising policy options for combined mitigation and adaptation in livestock systems at the regional level, and in particular policies required to ease the sector’s adaptation to climate change;
- understanding the relative cost-effectiveness of mitigation and adaptation measures;
- assessing the effects of current and planned government policies (e.g., Common Agricultural Policy, European Climate Change Programme) on the sector’s emissions and resilience to climate change;
- predicting the likely adjustments in the livestock economy (demand and supply sides) caused by adaptation and mitigation policies in the medium to long term;
- assessing the reaction of consumers to information on dietary additives, selective genetic modification, and other technical innovations that will contribute to mitigation and adaptation strategies; and

Figure 2. Methane measurement (INRA).
Conclusions

As countries enact policies to curb GHG emissions, the livestock sector will be a key component of these policy strategies. As these countries set ambitious targets for reductions in emissions, the agriculture industry will not escape notice and in this respect policy makers will expect the beef industry to contribute.

There are (and will increasingly be) technologies that will ensure that these targets can be met and at the same time improve the efficiency and profitability of the beef industry. The industry needs to work collaboratively with policy makers and other stakeholders across the chain to ensure that these win-win technologies are supported and put into practice.

Emissions from livestock systems that influence climate change are fundamentally different from other pollutants in that they impact to a much greater extent at a global level. Solutions must therefore involve international action and in particular allow participation by developing countries where most of the growth in demand and production will take place.

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