Abstract

1 CONTEXT

Reducing livestock greenhouse gas (GHG) emissions is now central to sustainable agricultural production strategies. Feedlot systems are a significant part of the production process in many countries, and associated feeding plans can influence product emission intensity significantly. Feed formulation can be used to target several objectives including animal productive performance, direct emissions from enteric fermentation and manure decomposition, and pre-farm gate emissions associated with the feed life cycles.

2 OBJECTIVE

To explore the environmental and economic trade-offs in feed formulation for beef cattle using multiobjective optimisation.

3 METHODS

We develop a multiobjective model to derive the efficient frontier between profit maximization and environmental impact minimization in diet formulation for beef cattle in a typical French feedlot system. The nonlinear profit function includes animal performance, animal selling price, and feeding costs. The environmental impact accounts for the feed ingredient life cycles (non-renewable energy consumption, phosphorus demand, soil acidification, soil eutrophication, climate change potential, and land requirement), and for methane and nitrous oxide emissions from enteric fermentation and manure decomposition. The model is solved using a combination of optimisation methods and for two scenarios with different weights representing the environmental impacts: a low carbon scenario (minimizing only CO_2eq emissions), and a balanced impacts scenario (minimizing the sum of impacts with an arbitrary choice of weights derived from the literature).

4 RESULTS AND CONCLUSIONS

We show that optimal cost-effective mitigation arises from a combined strategy, concurrently: increasing animal performance by 20% and reducing daily emissions from the feed life cycle by 50% and from enteric fermentation and manure decomposition emissions by 43%. With this strategy, both scenarios present similar

maximum GHG reduction in the feedlot phase – around 42% compared to the maximum-profit solution. The similar behaviour of both scenarios shows that environmental impact transference only occurs in more extreme solutions. Finally, about 50% of the total potential reduction can be achieved at a cost of 22 € / kg CO_2eq / kg CWE.

5 SIGNIFICANCE

Results suggest that significant GHG emissions reduction can be obtained solely from manipulating animal diets. Achieving these reductions cost-effectively derives from a combination of well-known strategies rather than focusing on any one individually.