The effect of dairy cow genotype on modelled greenhouse gas emissions derived from pasture based milk production systems

D.K. Lovett[1], L. Shalloo[2], P. Dillon[2] and F.P. O'Mara[1]
The Department of Animal Science, University College Dublin, Lyons Research Farm, Co. Dublin, Ireland Email: dan_lovett@talk21.com, [2]Dairy Production Department, Teagasc, Moorepark Production Research Centre, Fermoy, Co. Cork, Ireland

Keywords: greenhouse gas emissions, pastoral milk production, genotype, systems

Introduction A three-year systems comparison study was undertaken to see if progressively increasing the genetic potential for milk production of the dairy cow is desirable within pastoral based systems of spring milk production (Kennedy *et al*., 2002). The production data was inputted into the Moorepark Dairy System Model (MDSM) (Shalloo *et al*., 2004) to describe the economic, biological and production efficiency of each system. Output was then used to model whole farm greenhouse gas (GHG) emissions (Lovett et al., in press) from the nine systems studied (three concentrate levels by three genotype levels). Only the genotype effects are reported.

Materials and methods Based on their pedigree index (LP, < 100 kg, MP, 100 to 200 kg and HP, 200 to 300 kg), dairy cows of three different genetic potentials were fed three different levels of concentrate (376, 810 and 1540 kg cow yr^{-1}). Consequently, farm and herd size required to fill 468,000 kg of milk quota (at 36.0 g kg^{-1} fat) differed (29.7 to 39.10 ha^{-1} and 57.43 to 74.49 cows respectively). Annual N application rate and grazing days were fixed at 250 days and 330 kg N/ha. Using this production data, methane, nitrous oxide and carbon dioxide emissions were predicted using emission factors relevant to Northern Europe (Lovett et al., submitted). Both direct on-farm emissions (e.g. CH_4 from enteric fermentation) and indirect emissions (those associated with inputs used to maintain farm productivity such those associated with concentrate production) were simulated.

Results Annual, direct and total (direct and indirect) GHG were 351.6, 356.4 and 368.3 and 503.6, 510.1 and 527.1 Mg CO_2 equivalents for the LP, MP and HP systems respectively. The distribution of some of the GHG emissions by livestock category can be seen below in Table 1. Emissions of GHG's in relation to animal productivity increased with increasing genotype from 0.748 to 0.783 and 1.076 to 1.126 kg CO_2 equivalents per kg milk for direct and total emissions respectively. Farm profitability before tax, as predicted by the MDSM (Shalloo *et al*., 2004), was €44,446, €43,935 and €43,344 for the LP, MP and HP systems respectively.

Table 1 Predicted GHG emissions (Mg CO_2 equivalents) for spring based milk production as affected by genotype

System	LP	MP	HP
Direct GHG emissions	351.6	356.0	368.3
Indirect GHG emission	503.6	510.1	527.1
Direct sources of GHG emissions by herd category			
Lactating cows			
Enteric fermentation	185.2	180.1	176.2
Slurry/FYM storage and spreading	32.1	30.7	29.9
Excreta at pasture	9.8	9.6	9.4
Total	227.1	220.4	215.5
Non-lactating cows			
Enteric fermentation	35.6	44.1	56.1
Slurry/FYM storage and spreading	3.9	4.8	6.1
Excreta at pasture	2.3	2.9	3.7
Total	41.8	51.8	65.9

Conclusion Improving cow genotype for milk production reduces GHG emissions from the lactating herd. However, reduced herd fertility means that to fulfil quota allowances increased numbers of non-productive cattle must be maintained. Consequently, GHG emissions associated with the non-productive herd increase, with this increase being in excess of the reduction achieved within the lactating herd. Changes in breeding policy may have implications for national GHG emissions. In particular the recent introduction of a balanced breeding index to Ireland to simultaneous improve milk yield and fertility could reducing whole farm dairy sector GHG emissions.

References

Kennedy, J., P. Dillon, P. Faverdin, L. Delaby, F. Buckley, & M. Rath (2002). The influence of cow genetic merit for milk production on response to level of concentrate supplementation in a grass-based system. *Animal Science*, 75, 433-445.

Lovett, D.K., L. Shalloo, P. Dillon, F.P. O'Mara. A systems approach to quantify greenhouse gas fluxes from pastoral dairy production as affected by management regime. *Agricultural Systems,* (in press).

Shalloo, L., P. Dillon, J. O'Loughlin, M. Rath & M. Wallace (2004). Description and validation of the Moorepark Dairy System Model. *Journal of Dairy Science*, 87, 1945-1959.