Prediction of Methane Emission of Dairy Cows Offered Fresh Grass at Maintenance Level

Tianhai Yan
Agri-Food and Biosciences Institute, UK

C. S. Mayne
Agri-Food and Biosciences Institute, UK

The 21st International Grassland Congress / 8th International Rangeland Congress took place in Hohhot, China from June 29 through July 5, 2008.

Proceedings edited by Organizing Committee of 2008 IGC/IRC Conference

Published by Guangdong People's Publishing House

Prediction of methane emission of dairy cows offered fresh grass at maintenance level

T . Yan and C . S . Mayne
Agri-Food and Biosciences Institute ,Hillsborough ,County Down ,Northern Ireland BT26 6DR ,UK
Tianhai .yan@ afbini .gov .uk

Key words : cattle ,chemical composition ,fresh grass ,grass maturity ,methane emission

Introduction Methane (CH_4) production from cattle is a considerable source of greenhouse gases ,which is responsible for global warming . Fresh grass is the most important forage for ruminant animals across the world ,but there is little information available for prediction of CH_4 output from cattle offered fresh grass . The objective of the present study was to evaluate the relationship between CH_4 emission and nutritive value of fresh grass .

Materials and methods Fresh grass used was harvested daily from the primary growth of perennial ryegrass swards ,and offered to 2 groups of dry ,non-pregnant dairy cows (n=8) at maintenance level of energy intake ,with total collection of faeces and urine for 6 weeks (3 weeks/group) . The measurement period covered grass growth period from early growth to late maturity . An similar procedure was repeated for the first re-growth grass from the same swards . Details of the experimental design were presented previously (Yan *et al* . ,2008) . During each measurement week ,cattle were transferred to indirect respiration calorimeter chambers and housed there for 3 days with gaseous exchange measured during the final 2 days . Individual cow data (n=28) were used to develop equations for CH_4 emission .

Results and discussion The minimum ,maximum ,mean and s .d . values for CH_4 emission were 165 ,312 ,251 and 40 .1 l/d ,for CH_4 emission as a proportion of DM intake (DMI) 35 .6 ,48 .1 ,41 .7 and 3 .03 l/kg ,for CH_4 energy output (CH_4-E) as a proportion of GE intake (GEI) 0 .077 ,0 .105 ,0 .090 and 0 .0068 MJ/MJ . Methane output was strongly related to DMI (CH_4= 51 .4 DMI-57 ,R^2=0 .83) . A similar relationship was also obtained between CH_4-E and GEI ,i .e . ,CH_4-E=0 .119 GEI-3 .044 (R^2=0 .83) ,with CH_4-E being 0 .091 of GEI (R^2=0 .79) if the constant was omitted . These equations can be used to determine the ME concentration of fresh grass in combination with digestibility data from feed evaluation laboratories .

The second objective of the present study was to develop prediction equations for CH_4 output from fresh herbage data based on the chemical composition and also to evaluate mitigation strategies to reduce CH_4 output . The CH_4-E/DEI (DE intake) was positively related to concentration of DM ,NDF and ADF (Figure 1) ($P < 0.001$) and water soluble carbohydrates (WSC ,$P < 0.01$) ,while negatively related to concentration of CP ,lipid and ash ($P < 0.001$) and GE ($P < 0.05$) . The R^2 values in these linear relationships are 0 .43 ,0 .40 ,0 .57 ,0 .23 ,0 .59 ,0 .60 ,0 .68 and 0 .22 ,respectively . Using a stepwise technique ,3 multiple equations ([1] to [3]) have been developed to predict proportional CH_4 from chemical composition with reasonable R^2 values (0 .65 to 0 .77) . The unit for CH_4 is l/d ,for CH_4-E ,DEI and GEI MJ/d ,for DMI kg/d ,for GE MJ/kg DM ,for DM kg/kg ,and for other variables kg/kg DM . These results indicate that CH_4 can be predicted from chemical composition of fresh grass and manipulation of chemical composition of fresh grass is an effective strategy to reduce CH_4 output .

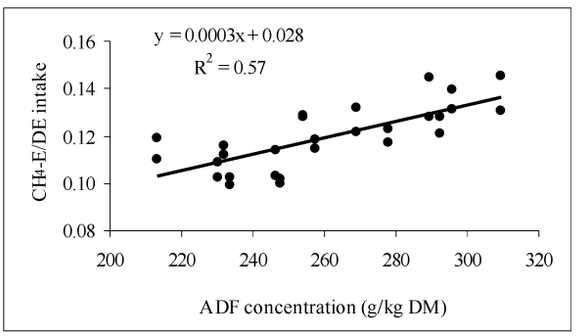

Figure 1 *Relationship between CH_4-E/DEI and ADF concentration of fresh grass .*

CH_4/DMI=14 .24 GE+24 .90 WSC−107 .50 CP−213 R^2=0 .65 [1]
CH_4-E/GEI=0 .028 GE−0 .312 CP−0 .048 NDF−0 .359 R^2=0 .67 [2]
CH_4-E/DEI=0 .152 ADF+0 .052 GE+0 .146 DM−1 .407 Lipid−0 .861 R^2=0 .77 [3]

Conclusions Methane energy output as a proportion of GE intake was 0 .091 with fresh grass offered at maintenance feeding level . Manipulation of chemical composition of fresh grass can reduce CH_4 ,and proportional CH_4 output can be predicted from chemical composition . These models have scientific and practical implications for ruminant feed evaluation .

Reference

Yan ,T . ,Ferris ,C . P . ,Porter ,M . G . and Mayne ,C . S . 2008 . Effects of grass maturity on metabolisable energy concentration of fresh grass . *Presented in the present Proceedings* .