

# Quantification of methane emissions from indoor-fed Fogera dairy cows using laser methane detector

Kobayashi Nobuyuki (Arid Land Research Center, Tottori University)  
[kobayashi.nobuyuki@tottori-u.ac.jp](mailto:kobayashi.nobuyuki@tottori-u.ac.jp) ☎+81-80-5064-6228

Hou F (Lanzhou Univ., China)  
 Tsunekawa A (Tottori Univ.)  
 Tianhai Y (Agri-Food & BioSci. Inst., UK)  
 Tegegne F, Tassew A, Mekuriaw Y (Bahir Dar Univ., Ethiopia);  
 Mekuriaw S, Hunegnaw B, Mekonnen W (Amhara Region Agri. Res. Inst., Ethiopia)  
 Ichinohe T (Shimane Univ., Japan)

## CH4 emissions from cattle

- \* 15% of greenhouse-gas emissions by human activities attributed to livestock farming; CH4 discharge from cattle is a major source.
- \* 5–7% of energy ingested by cattle released as the CH4 emissions.
- \* Accurate estimation and proper control of enteric CH4 production from cattle is indispensable.

## CH4-emissions measurement for cattle

- \* Respiration chambers. 
- \* SF6-tracer technique. 
- \* Spot-measuring method. 
- \* Measuring by sampling through a fistula into the rumen. 

These techniques are effective at controlled experiments; but their application at farm is still limited.

- \* Laser methane detector (LMD)  
 Portable/easily operated. Little disturbance of cow's activity.  
 Correlation with other conventional methods.  
However, not applied enough in practice for feeding trials.
- \* Feeding trial using LMD in drylands:  
 Drylands: serious soil erosion due to overgrazing, indoor cow production is encouraged.  
 Advantage of indoor-fed cow production for CH4 emissions: not well clarified.



## Hypothesis

- \* Correlation of the values measured by LMD with those by respiration chambers is applicable enough for the feeding trial.
- \* CH4 emissions from dairy cows differ between grazing and indoor feeding.

## Materials & methods:

- \* Experiment 1: Verification of values in the LMD with the values of CH4 production in respiration chambers.
  - 2 Simmental crossbred beef cattle (BW = 224 & 260kg) used in Linze research station, Gansu, China.
  - Provided roughage (wheat straw: oat hay = 50:50) & concentrate.
  - 2-night CH4 measurement by using LMD & respiratory chamber.
  - Recorded LMD-values: separated into eructation & respiration parts, assuming 2 normal distributions.



- \* Experiment 2: Application of the LMD in a feeding trial in Ethiopia.
  - Ethiopia: suffering from soil erosion caused by overgrazing.
  - 12 local Fogera dairy cows (average BW = 258kg) used.
  - 2-night CH4 measurement with LMD.
  - By using the equation estimated in Exp. 1, convert the LMD values into CH4 production.

## Treatments for Fogera dairy cows (Exp. 2)

Treatments↓	dietary allowance (kg DM/day)			parity
	Concentrate	Napiar grass	Natural hay	
Grazing	1.5	0.0	0.0	2.75
Natural hay	1.5	3.2	0.0	2.75
Napiar-grass hay	1.5	0.0	3.8	2.5



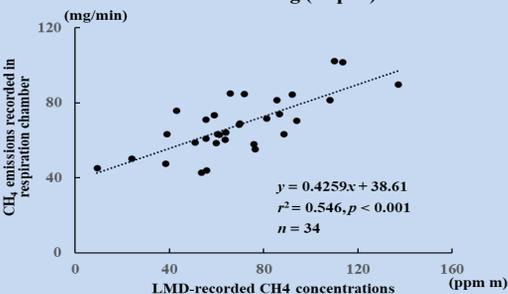
## Results (Experiment 1):

Correlation coefficients between respiration-chamber & LMD datasets (Exp. 1)

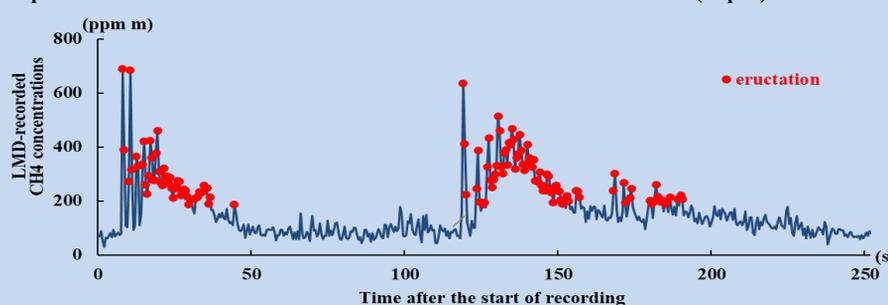
	Respiration	Eructation	Overall
Period after the LMD measurement (min)			
0	0.20**	0.12	0.12*
0–30	0.34***	0.12*	0.17*
0–60	0.55***	0.22**	0.30**
0–75	0.45***	0.17*	0.22**

\*, 0.01 ≤ p < 0.05; \*\*, 0.001 ≤ p < 0.01, \*\*\*, p < 0.001.

CH4 concentrations by LMD & respiration chamber for 60 min after LMD recording (Exp. 1)



Representative LMD-recorded CH4 concentrations of Simmental beef cattle (Exp. 1)



## Results (Experiment 2):

- \* No significant difference in CH4 emissions.
- \* Low DM intake and high milk yield in Napiar-grass group than in grazing.
- \* Estimated CH4 emissions less than those calculated by reported equation.

## Milk-production performance & CH4 emissions (Exp. 2)

Item	Grazing	Natural hay	Napiar-grass hay
Feed and nutrient intake			
DM, kg/day	5.84 <sup>a</sup>	4.20 <sup>c</sup>	4.93 <sup>b</sup>
NDF concentration, %	68.1 <sup>a</sup>	60.4 <sup>b</sup>	59.3 <sup>c</sup>
DM digestibility, %	57.4 <sup>a</sup>	46.4 <sup>b</sup>	50.8 <sup>ab</sup>
Milk yield, L/d/day	1.33	1.56	1.64
CH4 emissions			
g/day	65.9	69.5	66.1
g/kg-BW <sup>0.75</sup> /day	1.12	1.20	1.12
CH4-energy/GEI, %	3.26 <sup>c</sup>	5.00 <sup>a</sup>	3.99 <sup>b</sup>
BW gain, kg/day	0.25 <sup>ab</sup>	-0.07 <sup>b</sup>	0.55 <sup>a</sup>

p ≤ 0.05

## Major findings

- \* An equation to estimate CH4 emissions from LMD-CH4 concentrations was obtained.
- \* Indoor feeding by selected forage species (*i.e.*, Napier grass) showed higher milk yield, lower DM intake than those by grazing, and no significant difference in CH4 emissions.
- \* LMDs could be used to test feeding regimens of dairy cows with consideration to the CH4 emissions in areas under financial constraint; though further test against the other methods are still warranted.