

Methane emission from cattle

Dong Hongmin Professor
Li Yue Professor

Chinese Academy of Agricultural Sciences

E-mail: Donghm@cjac.org.cn

Outline

- China GHG problem and GHG policy
 - How to measure CH₄
 - Indicators for evaluating CH₄ emission rate
 - Suggestion on options
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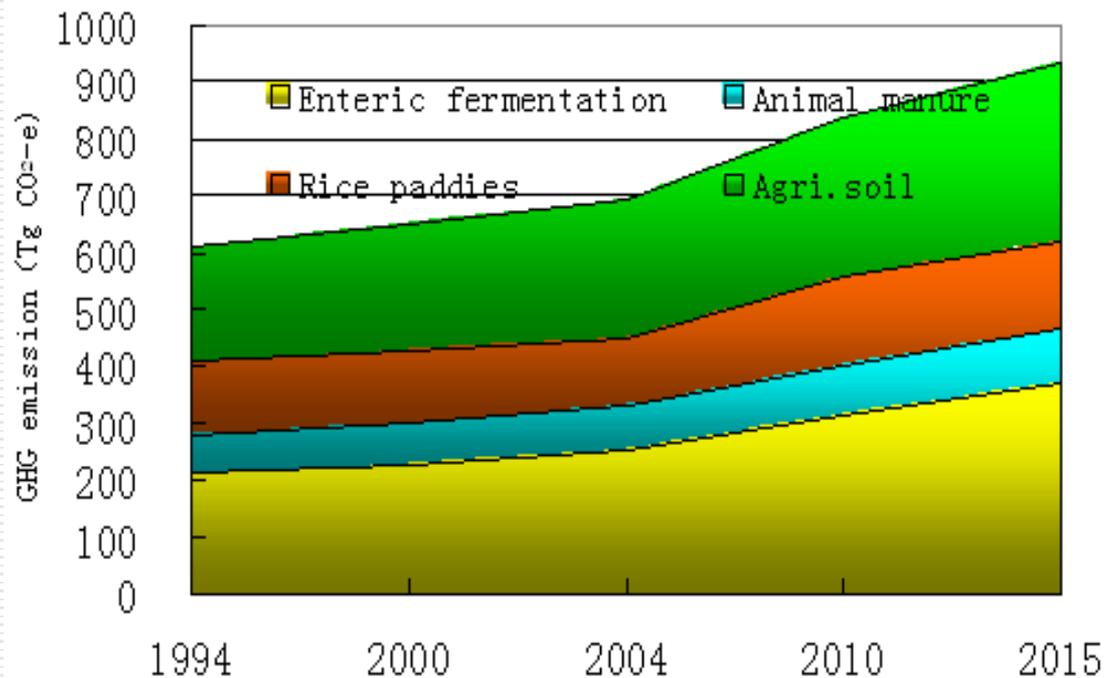
China GHG emission

- In 1994, China's total GHG emission was ~3650 million tons CO₂ equivalent of net emission
 - In 2004, China's total GHG emission is ~5600 million tons CO₂ equivalent
 - The annual average growth rate of GHG emission is around 4%
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GHG emission from agriculture sector

- GHG emission from agricultural sector accounted for 17% of China's total GHG emissions in 1994
 - CH₄ emission from agricultural sector contribute to 50% of China's total CH₄ emission
 - N₂O emission from agricultural sector accounted for 92% of China's total
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Projection of GHG emissions from agricultural sector in China



By 2015, GHG emission from agricultural sector would reach 900 Tg CO₂ equivalent, increase by 48% over 1994

The leading contributors to such increases would be livestock and fertiliser application

China Policy on mitigation GHG emission

- Mitigation is one of the important means to address climate change
 - According to the principle of “common but differentiated responsibilities” of UNFCCC, Annexed I parties should take the lead in reducing GHG emissions
 - China, as a developing country has less historical emission and current low per capita emission rates
 - China will stick to a sustainable development strategy and take such measures as energy conservation, ecological preservation and construction to control GHG emission
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Measuring CH₄

- Measure of enteric CH₄ emission rate
 - Chamber
 - SF₆ tracer
 - Head-hood
 - Tunnel method
 - Measure of manure CH₄ emission
 - Chamber
 - Simulation based on the current knowledge
 - Experiential model
 - Theoretical model
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Simulation of enteric CH₄

- many models

- $\text{CH}_4(\text{g}\cdot\text{d}^{-1}) = -37.47 + 47.71 \times \text{DMI}(\text{kg}\cdot\text{d}^{-1}) - 90 \times \text{DMI}(\text{kg}\cdot\text{d}^{-1})^2$
(Axelsson , 1949)
 - $M = \text{GEI}(\text{MJ}\cdot\text{d}^{-1}) \times (\text{Ym} \div 100) \times 365 \div 0.018$
where $\text{Ym} = 1.3 + 0.112D + L(2.37 - 0.05D)$
 - $\text{CH}_4(\text{g}\cdot\text{d}^{-1}) = -17.77 + 42.79\text{DMI}(\text{kg}\cdot\text{d}^{-1}) - 0.849\text{DMI}^2(\text{kg}\cdot\text{d}^{-1})$
 - $\text{CH}_4(\text{L}\cdot\text{d}^{-1}) = 29.48\text{DMI}(\text{kg}\cdot\text{d}^{-1}) + 14.28$
 - $\text{CH}_4(\text{L}\cdot\text{d}^{-1}) = 13.62\text{NFE}(\text{kg}\cdot\text{d}^{-1}) + 177.33$ (FAN Xia , 2004)
 - $\text{CH}_4(\text{L}\cdot\text{d}^{-1}) = 56.3 - 49.1\text{DMI}(\text{kg}\cdot\text{d}^{-1}) + 104.6\text{NFE}(\text{kg}\cdot\text{d}^{-1}) + 12.2\text{CP}(\text{kg}\cdot\text{d}^{-1})$ (YOU Yubo , 2008)
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Simulation of manure CH₄

□ IPCC default model

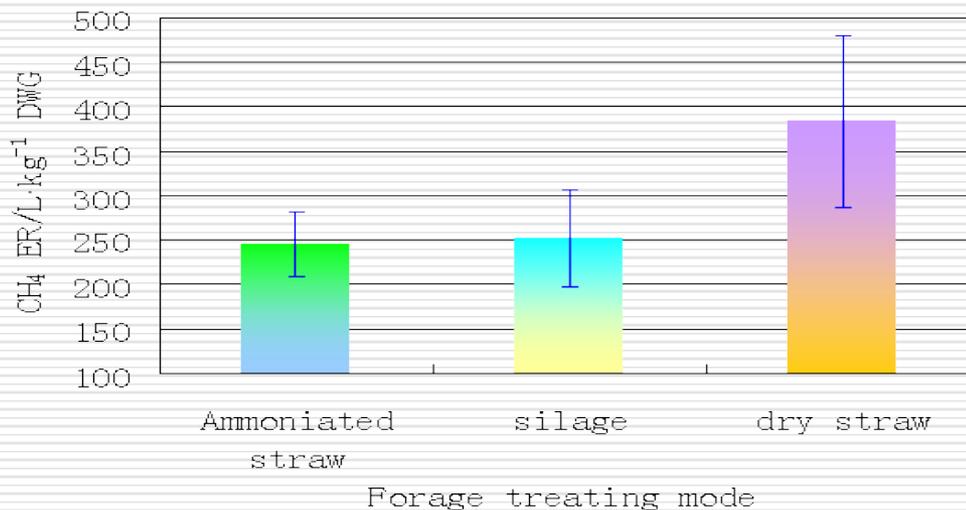
$$EF(T) = (VS_{(T)} \cdot 360) \cdot \left[B_{(T)} \cdot 0.77 \cdot \sum_{S,K} \frac{MCF_{S,K}}{100} \cdot MS_{(T,S,K)} \right]$$

CH₄ emission per animal

Reference	Animal type	Measure	CH ₄ /L·d ⁻¹
IPCC 2006 Guideline	Draft cattle	IPCC tier 1 default	187
DONG HM, 1998	Adult yellow cattle	IPCC tier 2	184
U.S. Johnson, 1994	Young cow	SF ₆	264
Canadian. McCaughey, 1999	Cow	SF ₆	373
Fanxia, Dong HM, 2004	Yellow cattle	SF6	224-248
U.K. Yan T, 2006	Dairy	Indirect chamber	209-220

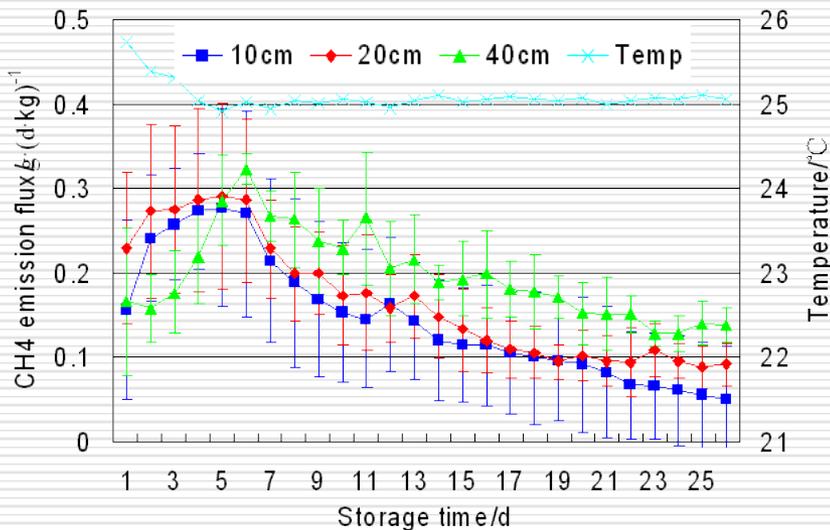
CH₄ emission per animal product

- CH₄ emission rate in units of L•d⁻¹.kg weight gain was:
- 245 for cattle fed ammoniated straw
- 252 for cattle fed silage
- 383 for cattle fed dry corn straw

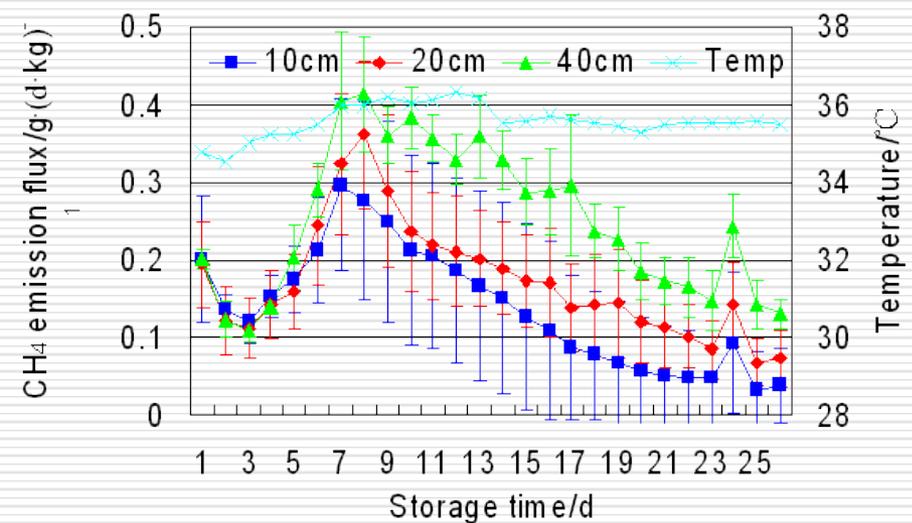


Manure CH₄ emission

- CH₄ emission rates during 26d ventilated storage period in 25 or 35°C were:
- a. 0.323 ± 0.018 declining to 0.051 ± 0.063 and
- b. 0.414 ± 0.073 to 0.033 ± 0.050 g•d⁻¹•kg⁻¹ initial manure



a Temperature 25°C



b Temperature 35°C

Meaning of CH₄ emission from livestock

- ❑ CH₄ emission from enteric fermentation is a normal progress of animal production.
 - ❑ Feed energy loss through CH₄ emission is about 2-12%.
 - ❑ Mitigation of GHG emission not only benefits global environment, but also improves feed utilisation.
 - ❑ Efficient mitigation will improve animal productivity.
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Mitigation Option 1

– Improve animal productivity

- Improve animal production efficiency to meet people's livestock product demands by less animal population, and reduced total GHG emission
 - System improvements include:
 - If young animals for meat can be grown to market size in half the time then total methane output is considerably reduced
 - If the same amount of meat, wool, cashmere, milk is produced from half the animals then less methane is emitted
 - Breed animals with higher efficiency of feed conversion
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Early results from Stage 1 model

	Siziwang	Taipusi	Sunan	Huanxian
Enterprise	mutton + cashmere	mutton	fine wool	mutton
Lambing month	Feb	Jan	May	Jan
Lamb sales after	7 mths	8 mths	4 mths	18 mths
Emission per sheep equiv. (kg CH ₄ / 50 kg animal / yr)	6.1	5.8	5.3	5.9
Emission per area (kg CH ₄ / ha pasture / yr)	3.0	14.7	5.2	16.4
Emission per production (kg CH ₄ / kg lamb meat / yr)	0.4	0.6	1.4	2.1

conversion factor used: IPCC Tier 2 (6.5% / 4.5% of energy intake)

- ▶ future works include more scenario analyses for each site (breed, supplement, ammoniation etc)

Mitigation Option 2

– Improve grassland quality

- Improve grassland quantity per animal and quality to increase animal productivity
 - Improve grassland quality to increase C stock
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Mitigation Option 3

– Forage treatment to improve feed quality

- Reduce CH₄ emission rate per animal by feeding treated forage: such as feed ammoniated corn straw and, or silage to replace the dry corn straw

