Methane emission from cattle

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Outline

- China GHG problem and GHG policy
- How to measure CH_4
- Indicators for evaluating CH_4 emission rate
- Suggestion on options

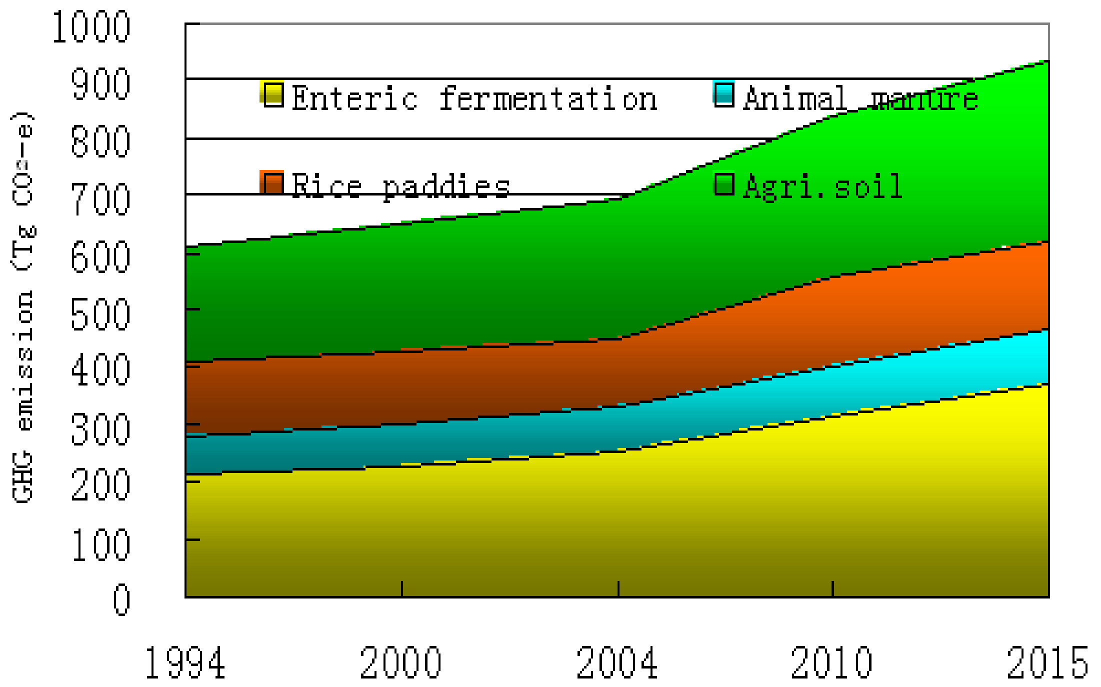
China GHG emission

- In 1994, China's total GHG emission was ~3650 million tons CO_2 equivalent of net emission
- In 2004, China's total GHG emission is ~5600 million tons CO_2 equivalent
- The annual average growth rate of GHG emission is around 4%

GHG emission from agriculture sector

- GHG emission from agricultural sector accounted for 17% of China’s total GHG emissions in 1994
- CH_4 emission from agricultural sector contribute to 50% of China's total CH_4 emission
- N_2O emission from agricultural sector accounted for 92% of China’s total

Projection of GHG emissions from agricultural sector in China



By 2015, GHG emission from agricultural sector would reach 900 Tg CO_2 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

Measuring CH_4

- Measure of enteric CH_4 emission rate
  - Chamber
  - SF_6 tracer
  - Head-hood
  - Tunnel method
- Measure of manure CH_4 emission
  - Chamber
- Simulation based on the current knowledge
  - Experiential model
  - Theoretical model

Simulation of enteric CH_4 - many models

- $CH_4(g \cdot d^{-1}) = -37.47 + 47.71 \times DMI(kg \cdot d^{-1}) - 90 \times DMI(kg \cdot d^{-1})^2$ (Axelsson， 1949)
- $M = GEI(MJ \cdot d^{-1}) \times (Ym \div 100) \times 365 \div 0.018$

  where $Ym = 1.3 + 0.112D + L(2.37 - 0.05D)$
- $CH_4(g \cdot d^{-1}) = -17.77 + 42.79DMI(kg \cdot d^{-1}) - 0.849DMI^2 (kg \cdot d^{-1})$
- $CH_4(L \cdot d^{-1}) = 29.48DMI(kg \cdot d^{-1}) + 14.28$
- $CH_4(L \cdot d^{-1}) = 13.62NFE(kg \cdot d^{-1}) + 177.33$ (FAN Xia， 2004)
- $CH_4(L \cdot d^{-1}) = 56.3 - 49.1DMI(kg \cdot d^{-1}) + 104.6NFE(kg \cdot d^{-1}) + 12.2CP(kg \cdot d^{-1})$ (YOU Yubo， 2008)

Simulation of manure CH_4

- IPCC default model

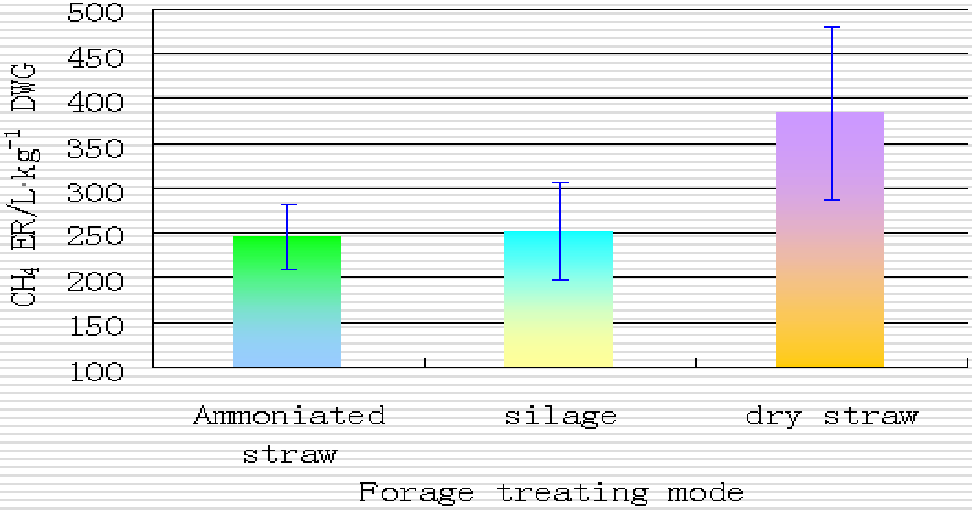
$$EF(T) = \left(VS_{(T)} \cdot ٣٦٥\right) \cdot \left[B_{٠(T)} \cdot ٠.٦٧ \cdot \sum_{S,K} \frac{MCF_{S,K}}{١٠٠} \cdot MS_{(T,S,K)} \right]$$

CH_4 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

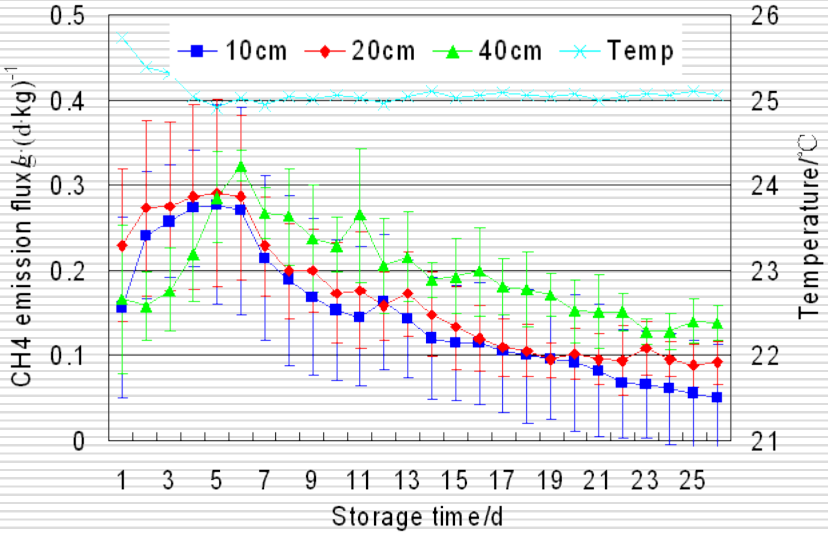
CH_4 emission per animal product

- CH_4 emission rate in units of $L \bullet d^{-1}$.kg weight gain was:
- 245 for cattle fed ammoniated straw
- 252 for cattle fed silage
- 383 for cattle fed dry corn straw

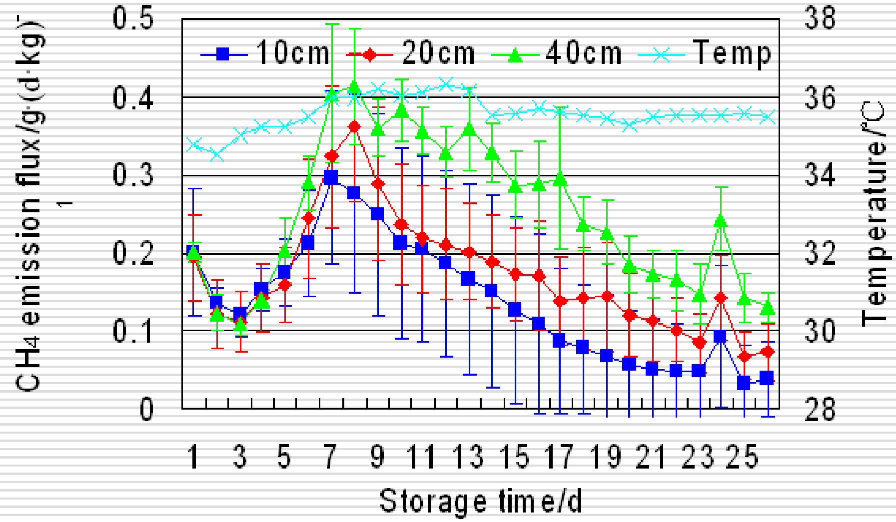


Manure CH_4 emission

- CH_4 emission rates during 26d ventilated storage period in 25 or 35℃ were:
- a. 0.323±0.018 declining to 0.051±0.063 and
- b. 0.414±0.073 to 0.033±0.050 $g \bullet d^{-1} \bullet kg^{-1}$ initial manure



a Temperature 25℃



b Temperature 35℃

Meaning of CH_4 emission from livestock

- CH_4 emission from enteric fermentation is a normal progress of animal production.
- Feed energy loss through CH_4 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.

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

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 eqiv. (kg CH4 / 50 kg animal / yr)	6.1	5.8	5.3	5.9
Emission per area (kg CH4 / ha pasture / yr)	3.0	14.7	5.2	**16.4**
Emission per production (kg CH4 / 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

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