Carbon Footprint Assessment and Mitigation Options of Dairy Farms in China

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China has put forward goal of carbon peaking and neutralization

On September 22, 2020, general secretary Xi Jinping solemnly declared in the general debate of the 75th UN General Assembly:

- China will enhance its National Determined Contribution
- Adopt more effective policies and measures, Strive for
- Carbon dioxide emissions to peak by 2030
- Carbon neutrality by 2060

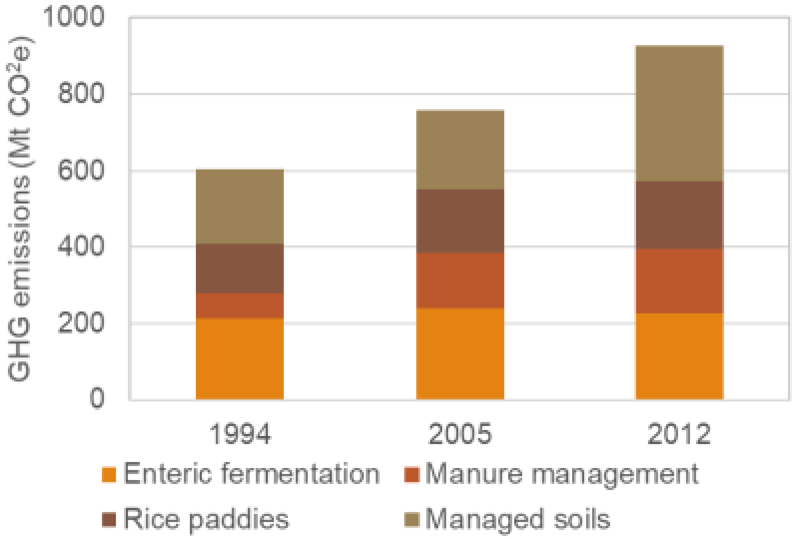
This important announcement highlights China's ambition and determination to cope with climate change,   green and low-carbon development.

Mandate Carbon Index in 14th five year plan of China

- Carbon dioxide emissions per unit of GDP shall reduce by 18% in the 14th Five-Year period
- Make plan to achieve the peaking of carbon dioxide emissions around 2030 and making efforts to peak early
- Build a system to reduce carbon intensity mainly and control total carbon emission
- Make efforts to control CH_4 and other GHGs

Livestock is one of major GHG emission sources in China

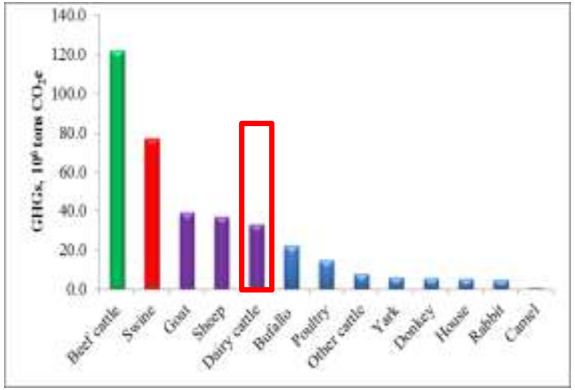
- The total livestock emission is 373 million tons CO2eq, contribute 40% of GHG emission from agriculture , 4 % of national emissions
  - Enteric CH_4 emission contribute 60.7%
  - CH_4 emission from manure management is 18.9%
  - N_2O emission from manure management is 20.4%

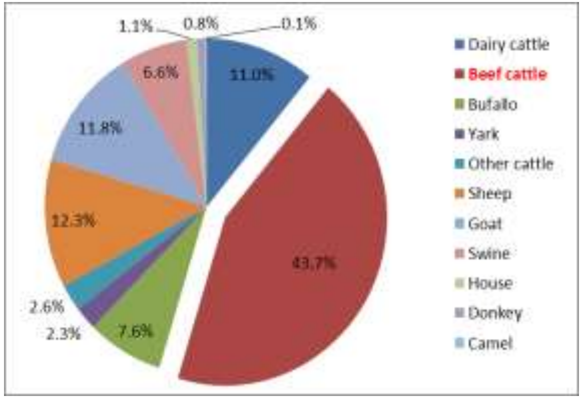


GHG emission from different subcategories of livestock sector

Contribution of different animals

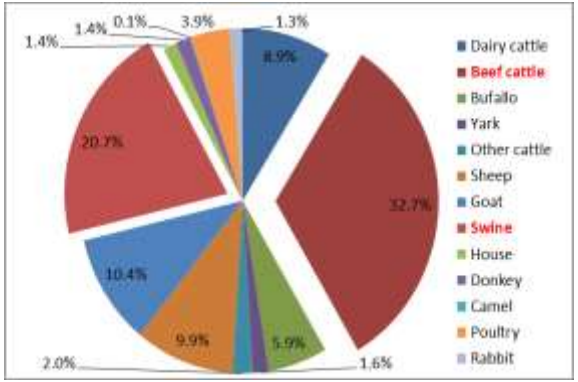
Dairy ranks top 5

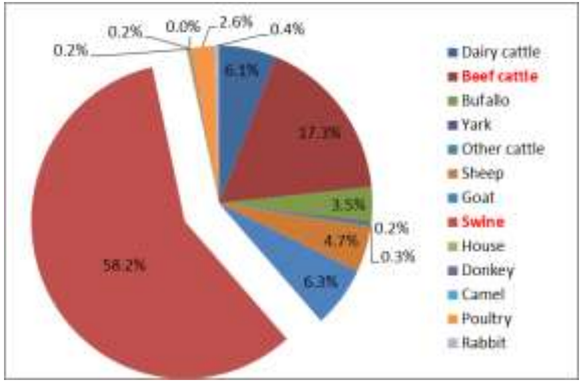




Enteric CH_4 emission
Dairy 11.0 %

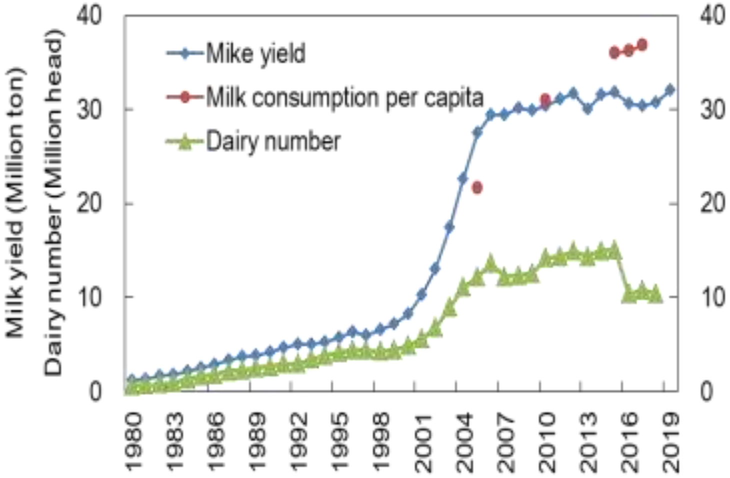
Manure N_2O emission
Dairy 8.9%





Manure CH_4
Dairy 6.1%

Revitalization of dairy industry–Safty and green production



- Dairy population increase 16 times
- Milk yield increased 28 times

China released dairy industry revitalization plan in 2018, to promote green production

- Over 65% dairy will raised in intensive farms (100head)
- Self-sufficiency of milk should maintain more than 70%
- The qualified rate of milk product is over 99%
- Manure utilization rate is over 75%
- **There is no quantity target of GHG**

What is the Carbon footprint of dairy milk, how to make assessment ?

Project mission of CCAFS (Climate Change, Agriculture and Food Security)

- Carbon Footprint Assessment and Mitigation Options of Dairy under Chinese Conditions' (2018-2019) jointly funded by CCAFS and the Sino-Dutch Dairy Development Center (SDDDC).
- Quantify Carbon footprint of GHG emissions, contributions by each sector for whole production chain
- Provide scientific data on CF baseline, identify potential mitigating measures
- Explore the way to implement mitigation options in dairy farm
- Make policy recommendation for achieving high quality, safety and green development of dairy industry.

CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security CCAFS

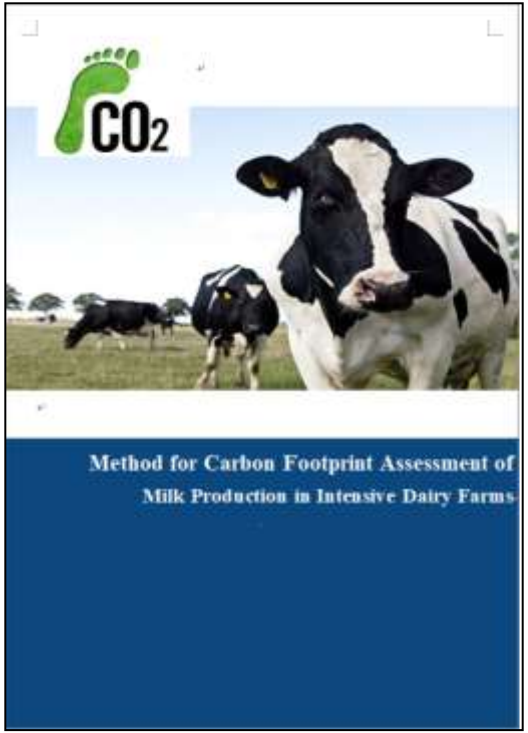
WAGENINGEN UNIVERSITY & RESEARCH

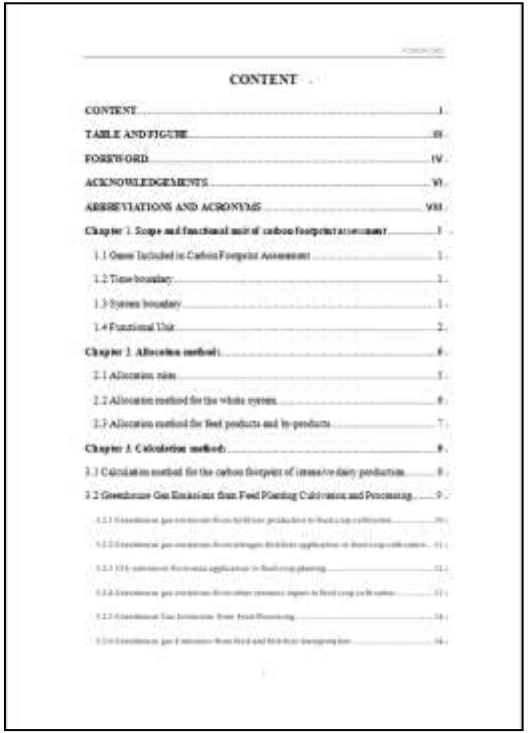
IEDA · CAAS

Deliverers of project

- Carbon Footprint Assessment and Mitigation Options of Dairy under Chinese Conditions' (2018-2019) jointly funded by CCAFS and the Sino-Dutch Dairy Development Center (SDDDC).
  - Carbon Footprint assessment methodology and tools
  - Carbon Footprint of different dairy farms
  - key mitigation points and technologies

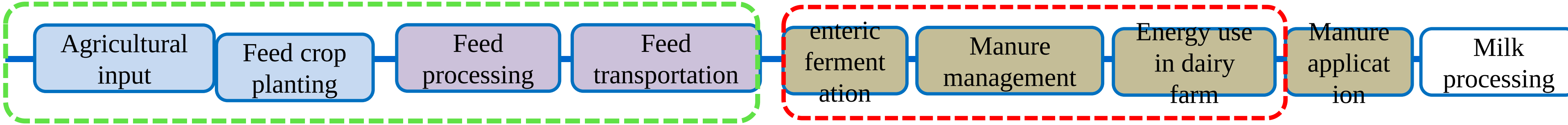
Methodology of Carbon footprint assessment of dairy cattle





CONTENT

Milk CF Composition



The system boundary includes 3 **modules**:

- GHG emissions in feed planting and processing
- GHG from dairy farm
  - ✓ CH4 for enteric fermentation
  - ✓ GHG from manure management
  - ✓ CO_2 from energy consumption in dairy farm
- GHG from manure treatment and land application outside of dairy farm

Calculation method of CF

$$CF_{milk} = \frac{[G_{feed} \times AF_i + G_{enteric} + G_{manure} + G_{energy} + G_{land}]}{M_{FPCM}} \times AF_p$$

式中：CF_{milk}： carbon footprint associated with milk (kg CO_2-eq)

G_{feed}： GHG emission from feed production (kg CO_2-eq)

$G_{enteric}$： CH_4 emissions from enteric fermentation(kg CO_2-eq)

G_{manure}： GHG emission from manure management, (kg CO_2-eq)

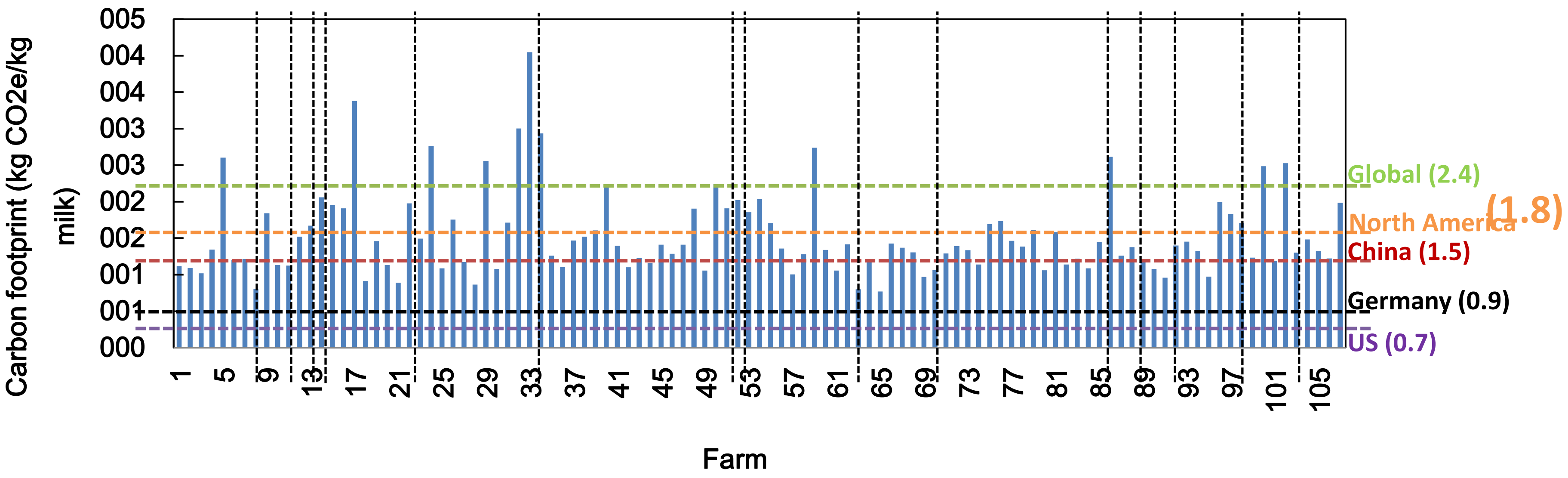
G_{land}： GHG emission from manure land use, (kg CO_2-eq)

G_{energy}： GHG emission from energy use, (kg CO_2-eq)

M_{FPCM}： the mass of milk production per year (kg LW)

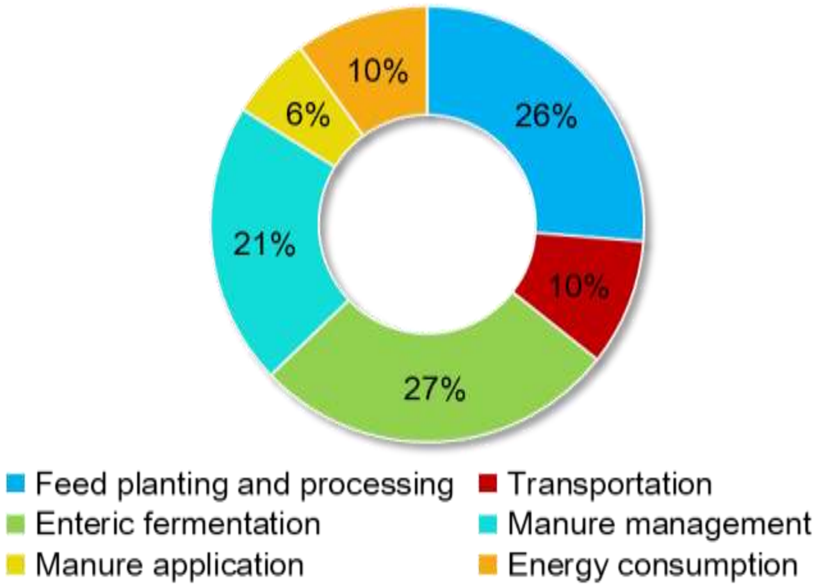
Tools of Carbon Footprint Assessment

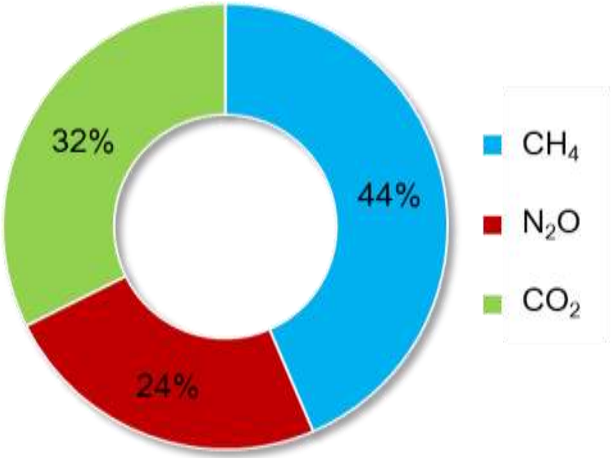
Carbon footprint of dairy farms in different regions



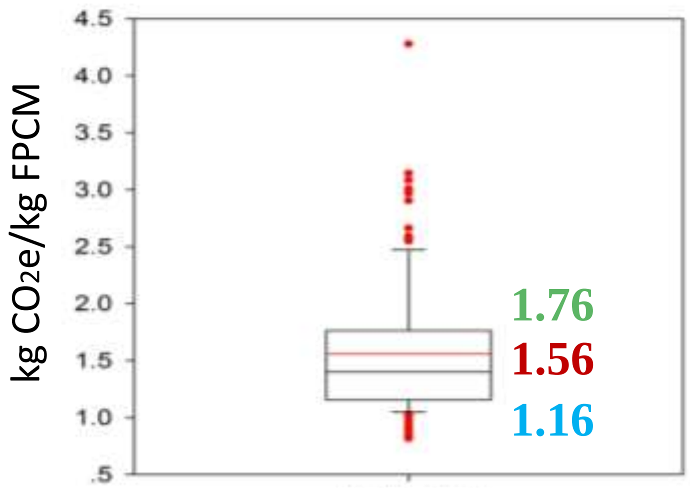
	Beijing	Tianjin	Hebei	Shanxi	Inner Mongolia	Heilongjiang	Liaoning	Fujian	Shandong	Guangdong	Henan	Ningxia	Shaanxi	Xinjiang	Chongqing	Guizhou
kg CO2e/kg milk	1.27	1.23	1.46	1.25	1.73	1.66	2.24	1.75	1.34	1.93	1.65	1.15	1.75	1.55	1.88	3.38
kg CO2e/kg FCRM	1.29	1.25	1.50	1.28	1.79	1.71	2.26	1.79	1.37	1.98	1.66	1.18	1.77	1.56	1.91	3.14
kg CO2e/head	6.26	5.58	7.39	6.34	6.00	6.82	5.68	9.30	6.18	8.33	5.83	5.94	6.93	5.46	7.70	11.49

Contribution of different stage and gas to carbon footprint

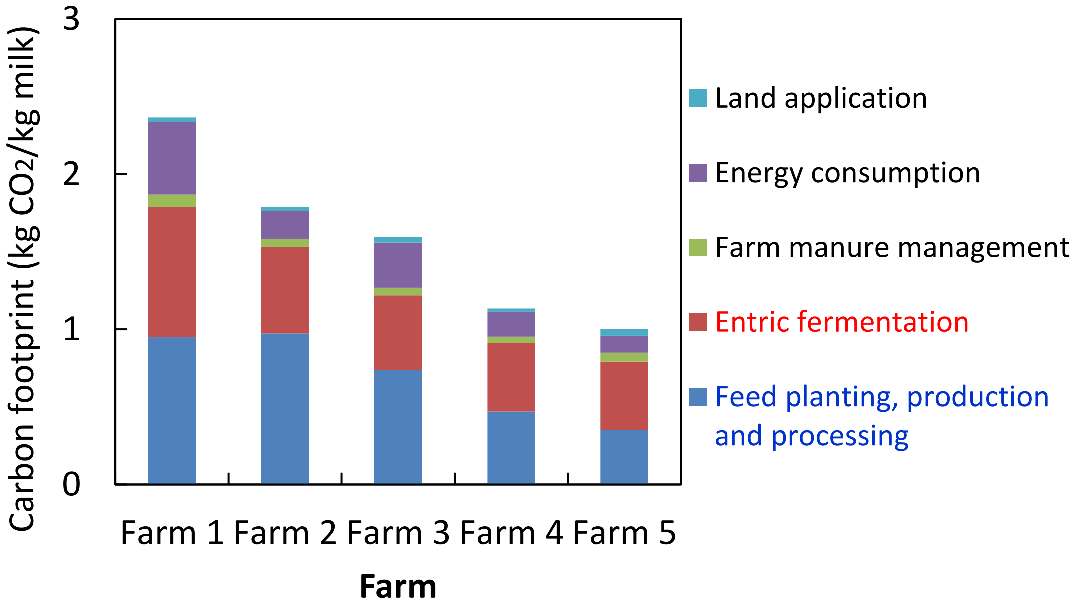




Contribution of different stage and gas to carbon footprint



No allocation
Average 1.9



Identify mitigation options– 3 steps

- Option inventory
- Expert voting

专家会议
Expert meeting

利益相关者
Stakeholder meeting

- Design questionnaire
- Stakeholder survey

- Farm survey
- Model assessment

农场调研
Farm survey

Selected mitigation options--- 31 technologies classified in 8 types

Herd management	**Feed production**
• Increase longevity (reduce replacement rate)	• Increased crop yields
• Decrease age at first calving	• Optimise fertilization efficiency
• Remove idle cows	• Increase nutritional value crops (feed quality)
• Improve health management	• Improve grazing management
• Optimise transition period	• Grazing management to avoid degradation of soils under natural grasslands
• Optimise young stock management	
Stable	• Slow release fertilizer
• Good construction contributes to herd performance	**Manure management**
• Close or modify playground	• Covered lagoon with methane oxidation
Feeding	• Anaerobic digestion
• Optimise rations (match cow requirements)	• Innovative techniques to improve manure management: primary manure separation, direct removal, and closed storage with thermal/biological oxidation to remove methane
• Reduce losses during feed storage	
• Optimise feed quality and composition	
• Avoid excess protein feeding	• Change manure land application methods from spread to injection
• Direct feeding of compound ingredients	
• Additives to reduce enteric methane (e.g. nitrate, 3NOP, fat, etc.)	**Energy management**
	• Production of renewable energy (wind/solar/manure)
Breeding	• Reduce fossil energy use / apply energy saving technologies in
• Genetic selection on feed efficiency	○ Farm (milking, cooling), processing
• Genetic selection on increased milk production	○ Feed cultivation (machines, transport)
• Genetic selection on low enteric CH_4	○ Feed processing
Carbon sequestration in soils	○ Milk processing
• Reduced tillage on crops	• Select crops with low energy requirements

Development of Guidelines for Mitigation Options

Guide for mitigation option of greenhouse gas emissions in Chinese dairy sector

Contents

For each option, following contents are included:

Technical principles

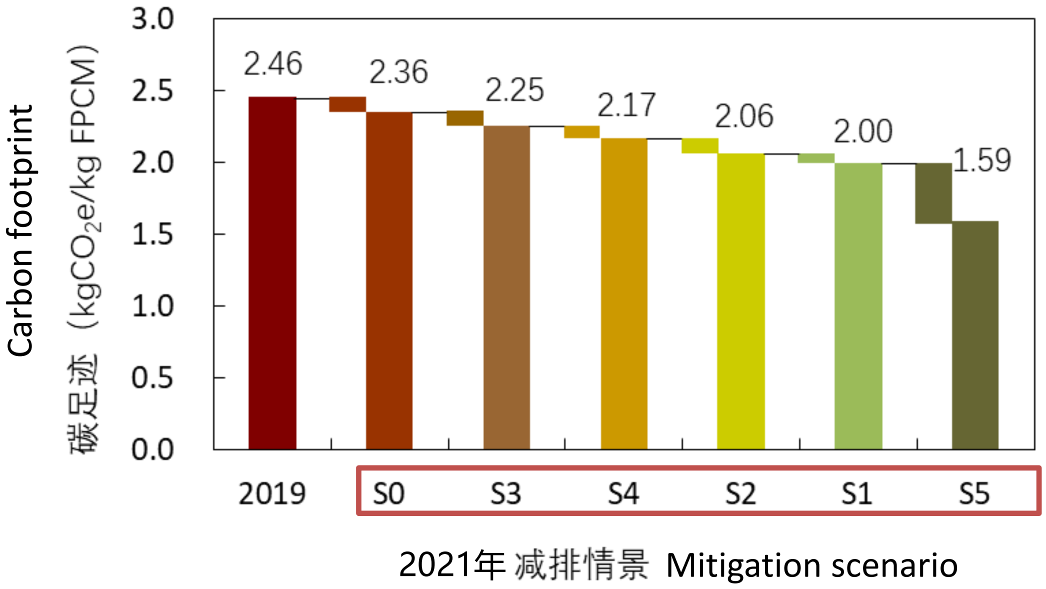
- Description
- Technical considerations to implementation
- Advantages and disadvantages

Mitigation potential

Cost and benefit

Case study

Mitigation option - One strategy for each farm



存栏：3155头
生产力：11.0吨/年/头

Stock number：3155head
Productivity：11.0 t/yr/head

S1：提高成母牛比例到55%

S2：饲料优化，减少精粗比到1.5，同时降低FCR到1.2

S3：优化粪便管理

S4：提高产奶量到12

S5：综合情景

Monitoring emission reduction of technologies on site

饲料
Feed

舔砖
Multi-nutrient Blocks

堆肥
Compost

污水氧化塘
Lagoon

Methodology of environmental assessment model in China

Finished

Carbon Footprint

On going

Nutrient cycling

Future

Water Footprint

Expectation for future collaboration

The experience on achieving improvement in animal productivity and environmental quality, comprehensive utilization of manure, and GHG mitigation simultaneously

- Develop New mitigation technologies (manure utilization, odor, ammonia, greenhouse gas)
- Enhance implementation of mitigation technologies (strategy, practice , pilot study, farm application)
- Take measures to attract private sector to invest in agricultural mitigation technologies
- Develop labeling system for mitigation in animal product (CF, Org.)
- How to MRV the progress of mitigation actions

谢谢

Thanks