Carbon Footprint Assessment and Mitigation Options of Dairy Farms in China

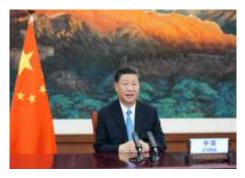
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China has put forward goal of carbon peaking and neutralization





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

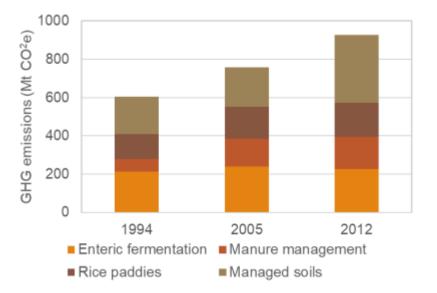
This important announcement highlights China's ambition and determination to cope with climate change, green and low-carbon development.

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
- $\square Make efforts to control CH₄ and other GHGs$

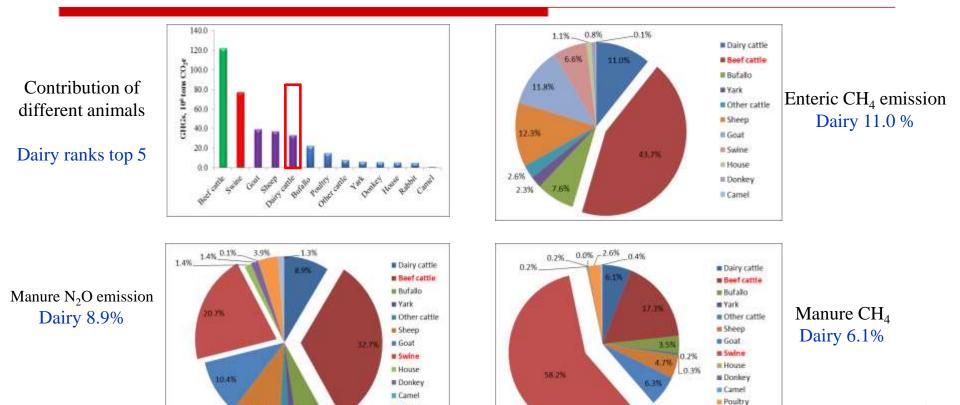
Livestock is one of major GHG emission sources in China

- 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%
 - CH₄ emission from manure management is 18.9%
 - N_2O emission from manure management is 20.4%





GHG emission from different subcategories of livestock sector



Rabbit

Poultry

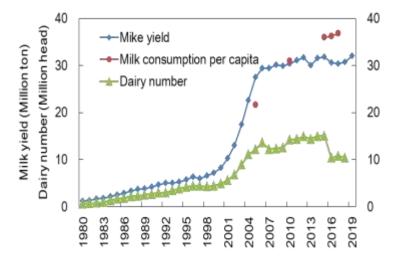
Rabbit

1.6%

0.9%

2.0%

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.



RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security









Deliverers of project

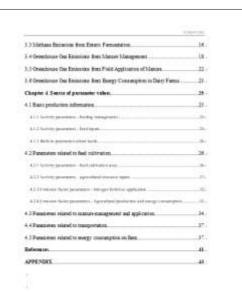
- Carbon Footprint Assessment and Mitigation Options of Dairy under Chinese Conditions' (2018-2019) jointly funded by CCAFS and the Sino-Dutch Dairy Development Center (SDDDC).
 - Carbon Footprint assessment methodology and tools
 - Carbon Footprint of different dairy farms
 - key mitigation points and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

Methodology of Carbon footprint assessment of dairy cattle

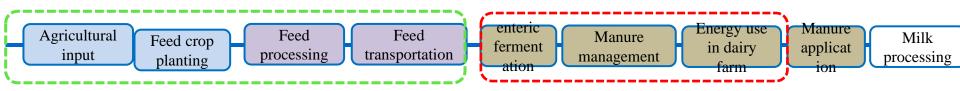


Method for Carbon Footprint Assessment of Milk Production in Intensive Dairy Farms

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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

$$CF_{milk} = \frac{\left[G_{feed} \times AF_{i} + G_{enteric} + G_{manure} + G_{energy} + G_{land}\right]}{M_{FPCM}} \times AF_{p}$$

式中: CF_{milk} : carbon footprint associated with milk (kg CO₂-eq) G_{feed} : GHG emission from feed production (kg CO₂-eq) $G_{enteric}$: CH₄ emissions from enteric fermentation(kg CO₂-eq) G_{manure} : GHG emission from manure management, (kg CO₂-eq) G_{land} : GHG emission from manure land use, (kg CO₂-eq) G_{energy} : GHG emission from energy use, (kg CO₂-eq) M_{FPCM} : the mass of milk production per year (kg LW)



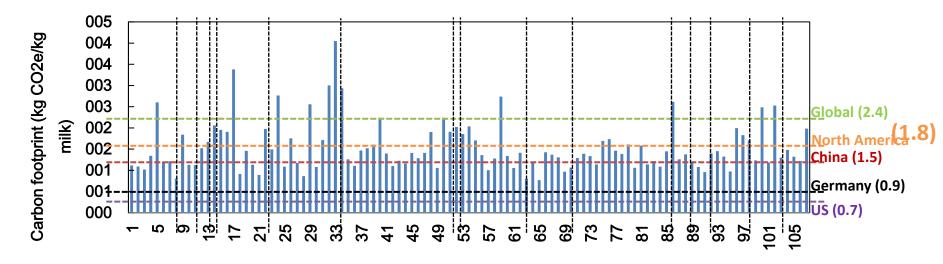
Tools of Carbon Footprint Assessment



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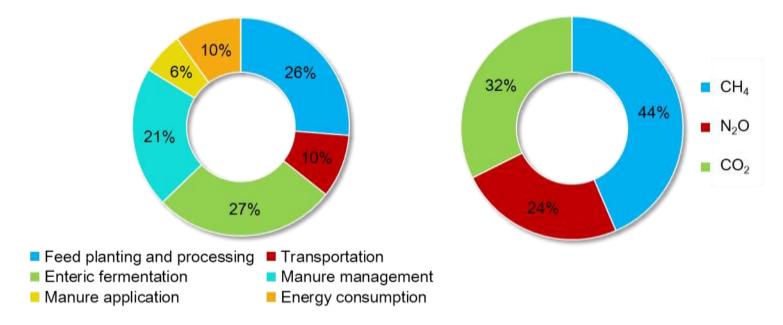
Carbon footprint of dairy farms in different regions



Farm

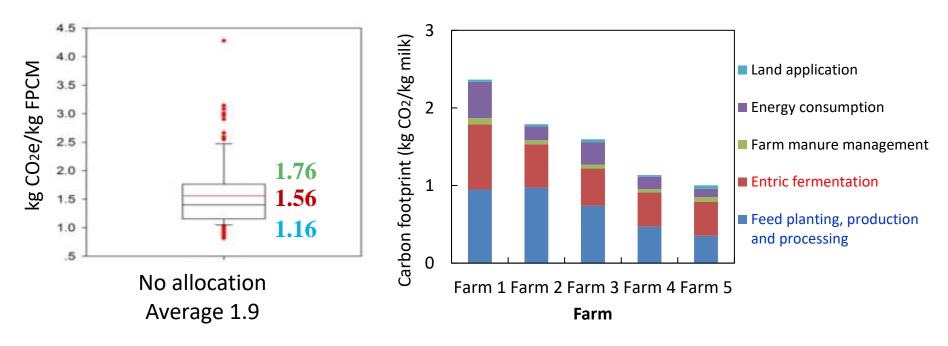
		Beijing	Tianjin	Hebei	Shanxi	Inner Mongolia	Heilongjia L ng	_iaonin g	Fujian	Shandong	Guangdon g	Henan	Ningxia	Shaanxi	Xinjiang	Chongqin g	Guizhou
k	g CO2e/kg milk	1.27	1.23	1.46	1.25	1.73	1.66	2.24	1.75	1.34	1.93	1.65	1.15	1.75	1.55	1.88	3.38
k	g CO2e/kg FCRM	1.29	1.25	1.50	1.28	1.79	1.71	2.26	1.79	1.37	1.98	1.66	1.18	1.77	1.56	1.91	3.14
k	g 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



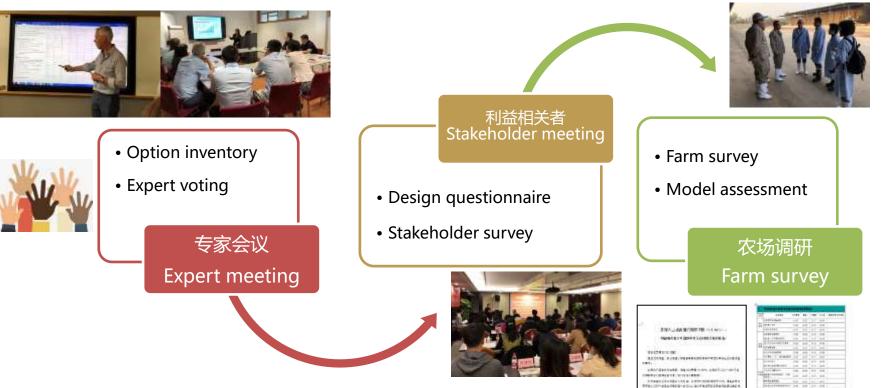


Contribution of different stage and gas to carbon footprint





Identify mitigation options– 3 steps



10.000

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

Herd	l 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
•	Optimise young stock management		grasslands
Stab	le	•	Slow release fertilizer
•	Good construction contributes to herd performance	Man	ure management
•	Close or modify playground	•	Covered lagoon with methane oxidation
Feed	ing	•	Anaerobic digestion
•	Optimise rations (match cow requirements)	•	Innovative techniques to improve manure management: primary
•	Reduce losses during feed storage		manure separation, direct removal, and closed storage with
•	Optimise feed quality and composition		thermal/biological oxidation to remove methane
•	Avoid excess protein feeding		Change many land any lighting mothed from any day initiation
•	Direct feeding of compound ingredients	•	Change manure land application methods from spread to injection
•	Additives to reduce enteric methane (e.g. nitrate, 3NOP, fat,	Ener	gy management
	etc.)	•	Production of renewable energy (wind/solar/manure)
Bree	ding	•	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
Carb	oon 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-

- ÷ .
- Editors' preface-Abstract-Abbreviations and acronyms-

Introduction

Givenhouse gas emissions in Chinese dary techorscope and approach-UCA accessment approach-

Mitigation options-

Breeding-Genetic selection on increased milk production-Genetic selection on feed efficiency-Genetic selection on low enteric CHarl Herd management-Improve health management-Remove Idle cowsincrease longevity-Optimize young stock management-Decrease age at first calving-Optimize transition period-Feed production and feeding-Feed stockation-Optimize fertilization efficiency-Intreased crop yieldsincrease nutritional value of crops (feed quality)inprove grazing management-Sow release fertilize-Feeding-Optimize rations (match cow requirements)-Avoid excess protein feesing-Direct feeding of compound ingredients-Additives to reduce enteric methaneinhibitora-Detary loids-SNOP-Optimize feed quality and composition-Reduce losses shring feed storage-

Stable-Good construction contributes to herd performance-Close or modify playpround-Manure collection/removal-At scrubbing in more closed barm-Manute management-Manure storage-Cover lagoon to avoid methane oxidation-Manure addition-Manure treatment -Anaembic digestion-Composting-Manure application-Change manure land application method from spreading to injection-Other manure management-Energy management-Production of renewable energy (wind/solar/biogas)-Energy saving technologies on Reduce fossil energy use-Select crops with low energy requirements-Carbon sequestration in solo-Reduced tillage on cropt-Interactions among mitigation options-

Interactions among feed additives, ration, enteric CHu and animal productivity-interactions among feeding practices, manure storage and land application-interactions among nutrient, animal health and productivity-

References

For each option, following contents are included:

Technical principles

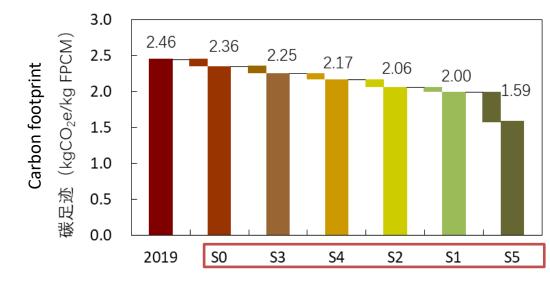
- Description
- Technical considerations to implementation
- Advantages and disadvantages Mitigation potential

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

2021年减排情景 Mitigation scenario

- 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



Methodology of environmental assessment model in China





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





