Report on CH_4 mitigation potential by the years 2025 and 2030 under different policy scenarios

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1. China's policies and planning on low-carbon development

(1) China's NDC and strengthened NDC

As proposed in its Nationally Determined Contributions (NDC) in June 2015, China is committed to peaking its CO_2 emissions as early as possible by 2030, cutting CO_2 emissions per unit of GDP by 60-65% from the 2005 level, increasing the share of non-fossil fuels in primary energy consumption to around 20%, and raising forest coverage by 4.5 billion m^3 compared with 2005.

At the General Debate of the 75th Session of the United Nations General Assembly in September 2020, Chinese President Xi Jinping outlined China's carbon neutrality goal for the first time. He pledged to scale up the country's NDC by adopting more vigorous policies and measures, have CO_2 emissions peak before 2030, and achieve carbon neutrality before 2060.

At the Climate Ambition Summit in December 2020, President Xi announced some further commitments for 2030: China will lower its carbon dioxide emissions per

unit of GDP by over 65% from the 2005 level, increase the share of non-fossil fuels in primary energy consumption to around 25%, increase the forest stock volume by 6 billion cubic meters from the 2005 level, and bring its total installed capacity of wind and solar power to over 1.2 billion kilowatts.

(2) MARA kicks off a new round of national genetic improvement program for livestock and poultry

After the rollout of the 14th Five-Year Plan, China set out on a new journey of fully building a socialist modernized country, and was committed to realizing the fundamental agricultural and rural modernization by 2035. Both the Central Economic Work Conference and Central Rural Work Conference drew a blueprint for the development of the breeding sector. The Central No.1 Document specified requirements for launching a new round of national genetic improvement program for livestock and poultry.

Under the guidance of the decisions and instructions of the Central Party Committee and State Council, the Ministry of Agriculture and Rural Affairs (MARA) led the formulation of the *National Program on Genetic Improvement for Livestock and Poultry (2021-2035)*. Six animals have been included: swine, dairy cattle, beef cattle, sheep and goats, layers, and broilers. The document outlined the goal of building a full-fledged system for commercial breeding within 15 years, and nurturing a group of technically-advanced animal breeds with international competitiveness, so as to ensure that China has proprietary rights to the most important germplasm, and lays the groundwork for its agricultural and rural modernization and people's wellbeing. The central indicators of livestock and poultry are listed as follows:

Table 1. The Central Indicators of Animal Productivity under the Program

Animals	Core indicators
Pigs	The daily gains of a 30-120 kg pig rise by 1% annually; For pigs younger than 160 days and above 120 kg, the number of piglets born by sows rises by 0.2 annually; the number of weaned piglets per year surpasses 32; and feed conversion rate for 30-120 kg pigs reaches 2.45:1.

Dairy cattle	The average milk yield of adult dairy cows in 2020 reaches 8300 kg, up by 3500 kg (73%) than 2008; and the annual milk yield of dairy cattle herd exceeds 9500 kg on average.
Beef cattle	Carcass weight of beef cattle increases by 15-20%; and milk produced by dairy and meat cattle rises by 10-20%.
Layers	High-yield layers of 700 days old produce over 500 eggs within 72 weeks; the feed-egg ratio reaches 1.9:1; and survival rate is over 96%.
Broilers	The bodyweight of commercial white-feather broilers of 42 days tops 2.8 kg; feed conversion rate goes below 1.6; chest muscle rate reaches 23%; and survival rate is over 95%.

(3) China's planning on the recycling of animal waste

The Chinese government will continuously push forward with the recycling of animal waste during the 14th Five-Year Plan period. The Fifth Plenary Session of the 19th Central Committee of the Communist Party of China highlighted the need to improve grain yield through land conservation, accelerate eco-friendly and low-carbon development, and control pollution. MARA has drawn up the *National Plan on Integrating Animal Husbandry with Cropping through Recycling of Animal Waste during the 14th Five-Year Plan Period.* This Document sets the target of raising comprehensive reutilization rate of animal waste to 80% by 2025. *The Policy Guidance on the System and Mechanism of Innovating and Promoting the Green Development of Agriculture* issued by the Chinese government envisions the reutilization of almost all agricultural wastes by the year 2030.

2. Assessment of China's manure management methane emissions under baseline

This paper will refer major productivity parameters of 2025 and 2030 to those of 2016, the base year, including the share of feed quality and production yield, farming model (large-scale, small scale and house hold), population makeup (reproductive female, newborns and other adult stocks), and manure management methods (grazing, daily fertilization, solid storage, open-air drying, liquid storage, oxidation ponds, cesspit storage within confinement sheds, biogas tanks, combustion, beddings, composting, aerobic treatment, etc.). It studies how livestock yield may alter if the indicators above remain unchanged.

The study predicts how demand for animal products changes with China's GDP, people's living standard and urbanization rate, and methane emissions trajectory during animal manure management in 2025 and 2030 compared with the base year. The results show: In 2025 and 2030, China's methane emissions during animal manure management will reach 3.374 and 3.4427 million tons respectively, up by 6.5% and 8.7% than 2016. Pig farming is the primary source for methane emissions, followed by beef cattle. The methane emitted by swine farming will account for 59.8% and 58.9% in 2025 and 2030 respectively, while that by beef cattle farming 17.1% and 18.0% respectively (graph 1 and graph 2).

Pig farming is the top emitter for greenhouse gases that draws the most attention, mainly because of its massive farming scale and large amount of slurry growing in proportion to farming scale. Predictions show: during 2025 and 2030, methane emissions of animal manure management will climb up slowly at an annual rate of 0.4%. That is why the growing demand for animal products will drive GHG emissions higher if no emission reduction measures are taken. In order to peak GHG emissions by 2030 in all sectors, it is imperative to take necessary actions to cut overall GHG emissions step by step.

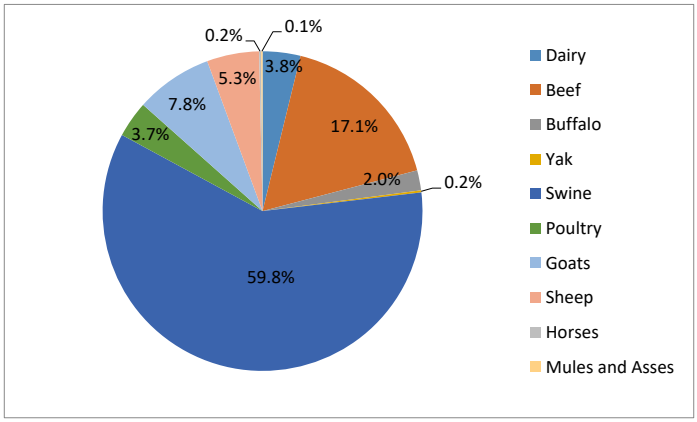

Fig.1 Proportion of CH_4 emissions from different animal type manure management in 2025

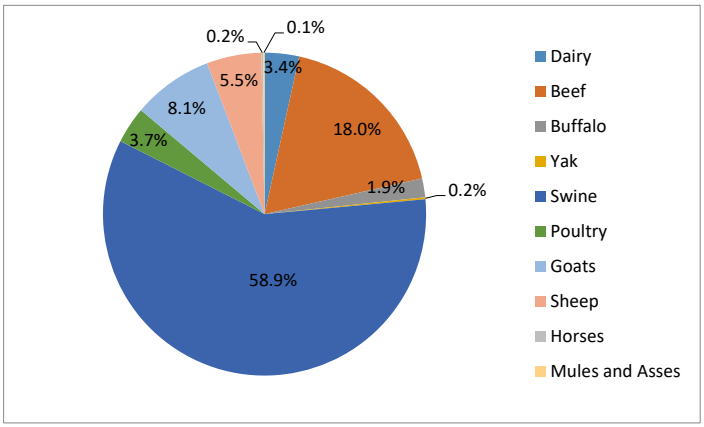

Fig.2 Proportion of CH_4 emissions from different animal type manure management in 2030

3. Potential for methane emission reduction under different scenarios

(1) Analysis of emission reduction potential through productivity improvement

Based on the *National Scheme on Genetic Improvement for Livestock and Poultry (2021-2035)*, China will steadily improve the production capacity of livestock and poultry by 2030. This report will shed light on the productivity of major animals in the base year, 2025 and 2030. Specific parameters are listed in the following table (milk yield refers to the yield of all dairy cattle in stock):

Table2 The major animal productivity under different years

Animal productivity	Unit	2016	2025	2030
Cattle meat	kg/head	150.4	158.0	165.4
Chicken meat	kg/head	2.07	2.10	2.15
Pork	kg/head	78.2	82.0	86.0
Sheep meat	kg/head	15.7	16.8	17.8
Eggs	kg/head	14.2	14.9	15.6
Milk	kg/head	3376.8	5220	5460

Based on the yield variation of animals in table 2, and when manure management methods remain the same, China's methane emissions of animal waste will exceed 3.237 and 3.217 million tons in 2025 and 2030 respectively under this context, down

by 4.2% and 7.0% than the baseline. The amount of methane emissions in 2025 is higher than that of 2030, signifying the peak reached ahead of schedule. In terms of animal breeds, dairy cattle promise the highest possibility of emission reduction by 2025, namely 28.8% compared with the baseline, but lower to 12.3% by 2030. The possibilities for swine, beef cattle, and meat sheep are all under 5% by 2025, but slightly higher to 5.3%, 7.8% and 8.2% by 2030.

(2) Analysis of emission reduction potential through improved manure management

In 2017, the General Office of the State Council released the *Opinions on Accelerating the Recycling of Animal Waste*. Guided by the spirit of source cut, middle control and end reuse advocated by the *Opinions*, large livestock farming counties and large-scale farms will be a priority in turning animal waste into biogas and bio natural gas to produce agricultural biological fertilizers and rural energy.

Such efforts will focus on composting of solid waste and anaerobic digestion of liquid waste. Judged by China's existing manure management methods, solid reserves turn to aerobic compost at a rate 2% every 5 years, while liquid reserves turn to biogas at a rate of 5% every 5 years. Against such backdrop, China's methane emissions in 2025 and 2030 will top 2.534 and 2.202 million tons respectively, down by 24.9% and 36.0% than the base year. The total emissions in 2025 will be 13.1% higher than that in 2030. Different kinds of animal breeds show similar potential of emission reduction after waste management methods are changed. This thesis mainly covers dairy cattle, beef cattle, swine and meat sheep sectors, whose emissions will drop by 20.3-43.7% in 2025, and 29.7-63.8% in 2030 than the baseline.

(3) Analysis of emission reduction potential through holistic approaches

If the improvement of yield parameters and waste management methods materialize together, the domestic methane emissions of animal manure management will 2.434 and 2.061 million tons in 2025 and 2030, down by 27.9% and 40.2% respectively than the baseline. The total emission equivalents in 2025 will be 15.3% higher than 2030. Various kinds of animal breeds show similar emission reduction

potential to the previous two scenarios. Emissions will decrease by 20.3%-43.7% in 2025 and 29.7%-63.8% in 2030 compared with the baseline.

As the Chinese government steps up its support for the recycling of animal waste and does its utmost in achieving carbon emission peak and carbon neutrality, China's methane emissions during animal manure management will be significantly reduced down the road (figure 3).

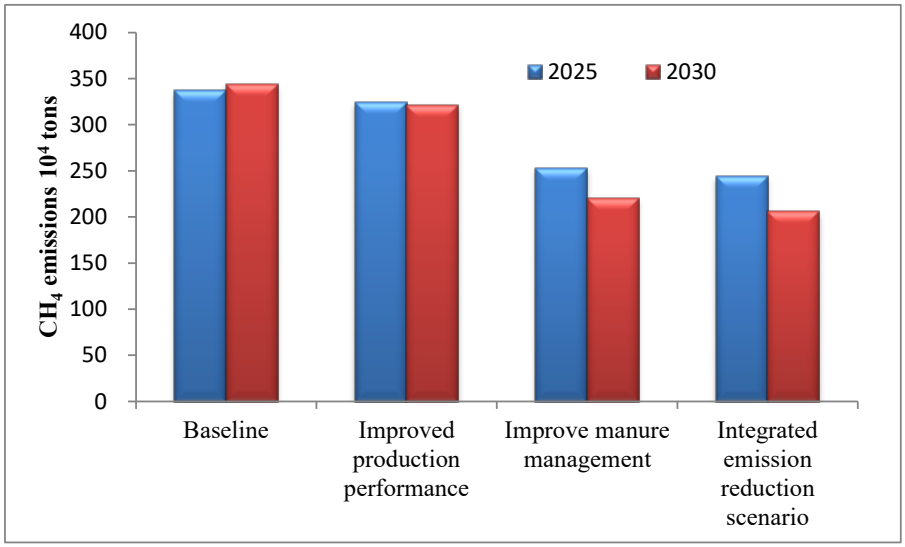

Fig.3 CH_4 emission reduction potential of China's livestock manure management in 2025 and 2030

4. Policy suggestions

China is an big country with large animal populztion. Animal manure management is one of the major contributor to methane emissions. As China's livestock sector features sustained development and increasing scale, GHG emission reduction during animal manure management will surely become a priority in GHG mitigation in agricultural sector. This paper proposes the following policy suggestions in order to speed up GHG mitigation in animal manure management:

a. Pursuing eco-friendly and high-quality development of animal husbandry. It is recommend to put equal emphasis on the growth of livestock sector and environmental protection in light of social and local conditions, and integration of s GHG mitigation and pollution control of animal manure , in pursuit of eco-friendly, low-carbon and high-quality development.

b. Enhancing policy support to mitigation by manure utilization. It is recommend

to practice the genetic improvement scheme for livestock and poultry, to continue the implementation of the recycling program of animal manure at county level. It is necessary to scale up aerobic composting of solid manure, and closed-up storage or liquid waste before and/or after turning into biogas, and decarbonize animal waste while controlling pollution.

c. Strengthening research on green and low-carbon technologies. It is important to study and promote low-cost technologies for closed-up aerobic composting and fermentation, encourage mixed fermentation of animal waste with other wastes, and improve biogas production efficiency and methane recycling rate. It is also indispensible to regulate technical standards of green and low-carbon livestock farming, replicate and apply green and low-carbon technologies, and underpin sustainable and low-carbon development of animal husbandry.