ISSN 2959-6157

The low-carbon development path of China's animal husbandry industry

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Abstract:

To address global warming, China has committed to achieving carbon neutrality by 2060. As a major source of carbon emissions in China, it is necessary to implement carbon reduction measures in animal husbandry. This paper mainly explores the mainstream low-carbon development measures for animal husbandry from three aspects: production, processing, and transportation. At the same time, suggestions have been put forward for the green and low-carbon development of animal husbandry in the future, which can provide reference for research on low-carbon development of animal husbandry.

Keywords: Animal husbandry, Carbon emissions, Greenhouse gas,Technologies

Introduction

After the Industrial Revolution, human activities have led to a rapid increase in carbon emissions, resulting in the accumulation of significant amounts of greenhouse gases, such as carbon dioxide and methane, in the atmosphere. This accumulation has exacerbated the greenhouse effect, leading to global warming. Global warming has brought many problems, such as rising sea levels and increasing extreme weather, seriously threatening the safety of people in some regions. To address climate change and global warming, on December 12, 2015, the Paris Climate Change Conference adopted the Paris Agreement (PA), which prescribed arrangements for global action on climate change after 2020[1]. The long-term goal of the PA is to limit the rise in global average temperature to less than 2 °C above pre-industrial levels, trying to limit it to 1.5 °C[2].

In order to coordinate the internal and external aspects and promote the response to climate change, on September 22, 2020, Jinping Xi pledged that China will increase its national independent contribution, adopt more powerful policies and measures, and strive to peak CO_2 emissions before 2030, striving to achieve carbon neutrality before 2060[3]. From the current structure of greenhouse gas emissions, agriculture is the second largest source of greenhouse gas emissions, accounting for about 20% of the total emissions. Among them, agricultural land emissions and animal gut fermentation account for more than 60% of agricultural greenhouse gas emissions[4]. Therefore, reducing carbon emissions from China's livestock industry is very necessary. This paper discusses methods for reducing carbon emissions in China's livestock industry from multiple perspectives, providing reference for the green and low-carbon development of China's livestock industry.

1 The current development status of agriculture in China

China is, by a significant margin, Asia's and the world's largest emitter: it emits more than one-quarter of global emissions[5]. Meanwhile, China is also a major agricultural country. In 2019, China's greenhouse gas emissions reached 14 billion tons of CO_2 equivalent, of which agricultural activities contributed 830 million tons of carbon emissions, accounting for 7.42% of the total emissions, second only to emissions from energy activities and industrial production processes[6].

2 The current development status of animal husbandry in China

China's animal husbandry has achieved tremendous development in recent decades, with the proportion of livestock production value in agriculture increasing from less than 20% in 1980 to around 33%[7]. The greenhouse gas emissions generated by livestock and poultry farming account for approximately 14.5% of global anthropogenic greenhouse gas emissions. It is expected that by 2050, the greenhouse gas emissions generated by global livestock and poultry farming will increase by 39% compared to 2010[8]. As the world's largest producer of animal husbandry, mitigating carbon emissions of animal husbandry has become an essential scientific issue for China to align with coordinated economic and environmental development and cope with global climate change[9]. Based on greenhouse gas emissions data from animal husbandry in China from 1961 to 2020, it was found that greenhouse gas emissions from animal husbandry in China reached their peak in 1996 and have been decreasing since 2002. The poultry and livestock breeding pollution policy implemented in China since 2001 has played an effective role in suppressing pollution, but to achieve the dual bomb target, emission reduction still has a long way to go[10].

3 The main technologies and means of carbon reduction in animal husbandry

The carbon emissions of animal husbandry mainly come from three stages: production, processing, and transportation. The main emphasis was placed on pigs, cattle, sheep, poultry, eggs, milk, and other significant livestock products[11]. The carbon emissions from animal husbandry are mainly caused by CH4 conversion, accounting for 44% of the carbon emissions from animal husbandry. N20 emissions rank second, followed by CO2, accounting for approximately 29% and 27% of the total greenhouse gas emissions from animal husbandry production, respectively[12].

3.1 Production stage

Carbon emissions during the production phase of animal husbandry primarily stem from activities such as planting, transporting, and processing raw materials for animal husbandry, as well as livestock and poultry manure management and energy consumption according to gastrointestinal fermentation. The most important greenhouse gases produced by animal husbandry are methane and nitrous oxide, among which methane is mainly produced by the intestinal fermentation and fecal storage of animals. In the process of producing livestock and poultry feed, it is often necessary to use synthetic or organic fertilizers, which also produce nitrous oxide[13]. Therefore, the following measures can be taken to reduce carbon emissions in production:

3.1.1 Nutritional intervention

The carbon emissions produced by intestinal fermentation in ruminant animals are much higher than those in non ruminant animals[14]. Among the various CH4 mitigation strategies, nutritional intervention or dietary manipulation is the most effective and commonly used strategy to mitigate enteric CH4 emission in ruminant livestock[15]. Improving the quality of forage can improve the digestibility of feed and help reduce methane emissions from animal intestines[16].

Adding a certain amount of additives to feed can also reduce methane emissions. Adding oil to daily grains is a common method for reducing methane emissions[17]. Providing beef cattle with rapeseed oil, which accounts for about 5% of their daily feed intake, can reduce methane emissions by 18%[18]. Through experiments, it was found that cows, goats, and other animals can reduce methane emissions by adding fats to their feed[19-20].

Microbial feed additives are another important nutritional intervention in the CH4 mitigation studies[15]. For example, yeast cells can reduce the production of enteric CH4 by deviating hydrogen atoms from methanogens to acetogenic strains of ruminal bacteria to enhance the production of acetate[15]. Therefore, adding some chemical inhibitors such as nitrates to feed can also reduce methane emissions.

3.1.2 In terms of livestock breeds

Increasing animal productivity will generally reduce methane emissions per kg of product. Because of the improvement in production efficiency, a greater proportion of the energy in the animal feed is directed towards production of useful products and hence methane emissions per unit product is reduced[21].

Persisting in selecting high-quality animal husbandry breeds for breeding, strengthening the application for cultivating high-quality breeds, choosing high-quality breeding varieties, and improving the ability to cultivate good varieties can reduce carbon emissions from the starting point of animal husbandry[13].

3.1.3 Fecal treatment

Livestock and poultry manure is one of the main sources of CH4 and N2O emissions. The greenhouse gas emissions caused by livestock and poultry manure are influenced by factors such as farming scale, environmental conditions, manure removal methods, pile size, composting mode, and manure treatment technology[14]. In large-scale breeding farms, due to the large quantity and concentrated breeding areas, the accumulated livestock and poultry manure will produce a large amount of greenhouse gases after decomposition and decay. Reasonable treatment of feces can increase many benefits. CH4 emissions will increase with time, temperature, wind speed, and reactor size[22-24]. The following are several common methods for treating manure:

(1)energy conversion

The biogas generated from feces can be collected for power generation or purification of biogas. The rational treatment of biogas residue and slurry can be used to produce organic fertilizers for farmland.

(2)substrate conversion

Fermented feces can be used as substrate soil for cultivation. Through the fermentation process, animal waste is broken down and transformed into nutrient-rich compost. This compost can then be used as a sustainable and eco-friendly alternative to traditional soil, providing essential nutrients for plant growth and improving soil health. Using fermented feces in agriculture not only recycles waste but also enhances soil fertility and reduces the need for chemical fertilizers.

(3)feed conversion

The feces are processed through drying, fermentation, and decomposition methods for feeding pigs, fish, and insects[25].

3.1.4 Breeding environment and equipment

he production and processing of feed, as well as the large-scale breeding of livestock and poultry, all consume a large amount of energy and generate a large amount of greenhouse gases. CH4 emissions are affected by air temperature and ventilation flow rate. The emissions will increase with the increase of temperature[26]. Excessive ventilation can also lead to significant greenhouse gas emissions[27]. Therefore, it is very important to maintain a suitable temperature and ventilation environment for the growth of livestock and poultry. Try to use low-carbon and energy-saving equipment during the livestock and poultry process, and some old equipment needs to be replaced.

3.2 Processing and transportation

Livestock and poultry are subjected to live slaughtering and processing procedures before being deemed suitable for market consumption. This process requires significant energy use, resulting in substantial carbon emissions. Due to the particularity of livestock products, it is difficult to preserve them well from processing to transportation, and therefore, a large amount of carbon dioxide is emitted during the process of taking preservation measures[28]. People can rely on modern digital technology to develop a carpet transportation system for livestock products by optimizing transportation routes, improving transportation methods, and other measures[29].

4 Conclusions

As the largest source of agricultural carbon emissions, animal husbandry has a significant impact on China's carbon emissions.

Production, processing, and transportation can all serve as major breakthroughs in reducing carbon emissions in animal husbandry. The common methods for carbon reduction in animal husbandry currently include nutritional intervention, manure treatment, and improvement of breeding environment and equipment. The main carbon reduction measures are concentrated in the production stage, thus neglecting the importance of processing and transportation. In the future, attention should be paid to the overall optimization of the animal husbandry supply chain, combined with modern digital technology, to develop green and efficient animal husbandry.

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