CARBON NEUTRALITY AND SUSTAINABLE DEVELOPMENT IN ANIMAL HUSBANDRY

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Abstract

Carbon neutrality has become a global consensus and a core trend in development. Many countries are accelerating the development of green and low-carbon agricultural and animal husbandry technologies, steadily advancing the realization of the 2050 carbon neutrality goal. This conference will focus on sharing a series of research results from our team in the field of carbon neutrality and sustainable development in agriculture and animal husbandry, showcasing technical pathways and practical breakthroughs.

Keywords: agriculture, animal husbandry, green and low-carbon, sustainable development, carbon neutrality

INTRODUCTION

Global warming has become one of the most severe environmental challenges faced by humanity. The chain reactions it triggers, such as glacier melting and the frequent occurrence of extreme weather, are fundamentally threatening the balance of natural ecosystems and the sustainable development path of human society. As significant contributors to greenhouse gas emissions, agriculture and animal husbandry also possess enormous carbon sequestration potential and emission reduction capacity, making them key areas that cannot be ignored in global climate governance. Against this backdrop, developing and promoting green and low-carbon feed-livestock production technologies, to curb greenhouse gas emissions throughout the entire agricultural and livestock production chain from the source, is not only a core approach to advancing the green transformation of agriculture but also an inevitable choice to ensure global food security and ecological safety.

Our team has long focused on core areas such as the efficient utilization of crop straw resources, the integration of low-cost and high-quality livestock production technologies, precise reduction of greenhouse gas emissions, the practical application of smart agriculture technologies, and the construction of carbon-neutral pathways for the entire life cycle of agriculture and animal husbandry. Through interdisciplinary collaborative innovation and deep integration of industry, academia, research, and application, we are committed to providing feasible technical solutions and practical support for the high-quality development of green and low-carbon agriculture and animal husbandry in China and even globally (Fig. 1).

MATERIAL AND METHODS

Systematically review the resource types, regional yield distribution, and traditional disposal methods of global staple crop straws such as wheat, maize, and rice, as well as typical agricultural by-products, and quantify the carbon emission intensity and mitigation potential of different processing pathways. Monitor greenhouse gas emissions throughout the full cycle of silage fermentation to identify core reduction targets and action pathways.

Using a multi-omics combined analysis strategy including metagenomics, transcriptomics, metabolomics, and proteomics, analyze the multi-dimensional mechanisms of microbial-enzyme synergy between exogenous lactic acid bacteria and cellulase from aspects such as gene expression, protein regulation, and metabolic flux changes. Targeted development of multifunctional composite microbial agents that integrate efficiency improvement, emission reduction and carbon sequestration enhancement, and gut probiotic benefits.

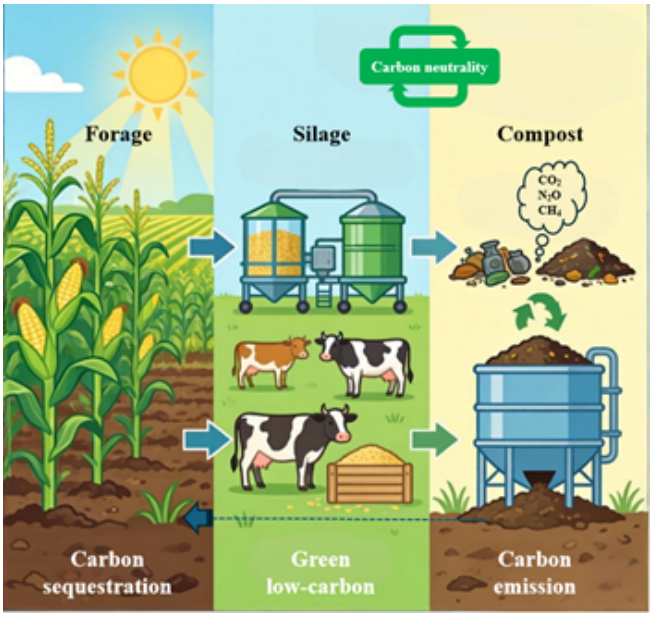

Fig. 1: Livestock production and carbon neutrality

Based on the fermentation characteristics of core silage feed types, greenhouse gas emission databases, and regional agricultural and livestock production parameters, construct a "Global Major Silage Feed Carbon Emission Dynamic Reduction Model" that couples resource endowment, production patterns, and mitigation technologies. Through multi-scenario simulation, optimize the combination of mitigation technologies to form a livestock and agricultural carbon neutrality technology pathway and implementation framework covering the entire chain from feed production and livestock farming to waste resource utilization.

RESULTS AND DISCUSSION

Silage fermentation regulation

By integrating third-generation sequencing microbiomics with untargeted metabolomics techniques, the dynamic microbial communities and metabolic regulatory networks during silage fermentation were systematically analyzed (Du *et al.* 2025). Based on indigenous wild lactic acid bacteria resources, a composite microbial preparation with synergistic effects of lactic acid bacteria and cellulase was developed, promoting the industrialization of scientific research results and upgrading silage feed into high value-added products with market circulation attributes. This preparation has been applied on a large

https://doi.org/10.11118/978-80-7701-093-1-0064

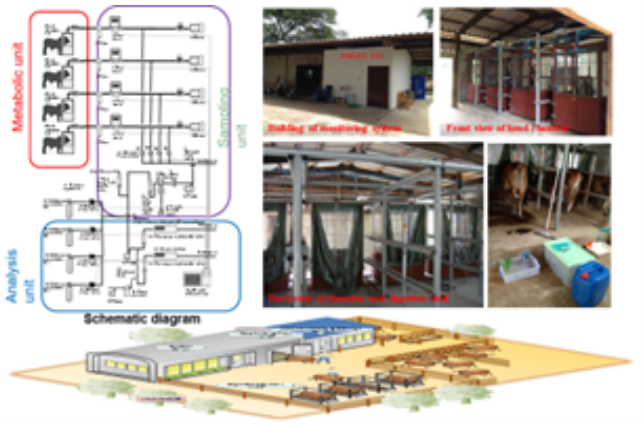

Fig. 2: Livestock greenhouse gas monitoring System

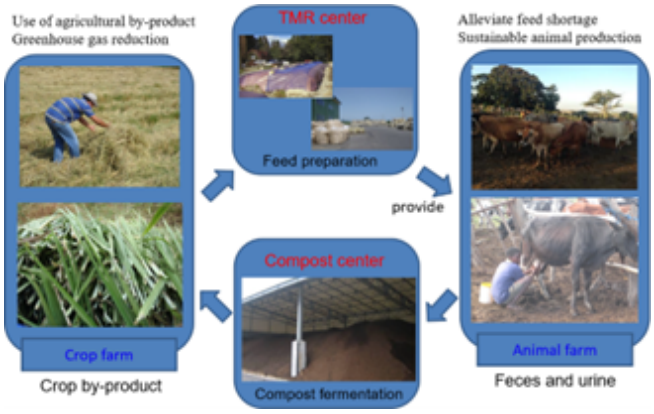

Fig. 3: Collaborative Production Model of Crops and Livestock

scale for forage silage production in Japan, Southeast Asia, and tropical regions of Africa, significantly improving the fermentation stability and nutrient retention of silage feed, while also enhancing the daily weight gain and feed conversion efficiency of ruminants.

Eco-agriculture model of zero biological waste

Through collaborative efforts among industry, academia, and research, a feed processing system has been established using tea dregs, coffee grounds, vegetable residues, and fruit residues as raw materials. After standardized processing, the aforementioned food waste can be used as high-nutrition alternative feed for dairy and beef cattle, significantly improving feed resource utilization. At the same time, a closed-loop resource utilization system for food waste has been created, integrating 'food manufacturing factories-feed processing enterprises-large-scale farms,' promoting a biological resource recycling production model where food manufacturing factories achieve nearly zero food waste emissions. This system effectively supports environmentally friendly agricultural development and improves the self-sufficiency of feed raw materials and the production efficiency of dairy and beef cattle (Cai *et al.* 2025).

Monitoring and Reduction of Greenhouse Gas Emissions from Livestock

In Southeast Asia, a 'Real-time Monitoring System for Livestock Greenhouse Gas Emissions' (Fig. 2) has been established. Based on this monitoring system, a low-carbon feed production system has been developed, using regional crop straw and food waste as the main raw materials. In addition, precise feeding and rumen regulation technologies have been developed to significantly suppress methane (CH_4) emissions. This system notably reduces feed costs, increases daily weight gain of beef cattle, and lowers methane emission intensity per unit of livestock product, providing key technological support for the low-carbon transformation of livestock farming in Southeast Asia and regional climate mitigation goals.

Construction of a Crop-Livestock Integrated Production Model

Systematically promote the 'crop-livestock coordinated production model' among small-scale farmers (Fig. 3), establishing a four-in-one circular production system of ‚agricultural by-product resources-livestock feeding-compost return to fields-crop cultivation.' This model is based on the nutritional needs of ruminants, using agricultural by-products as the base material to formulate a full-price mixed fermented feed. The model effectively increases farmers' self-sufficiency in feed, reduces the cost of purchased protein feed, and simultaneously promotes annual milk production and carcass weight in dairy and beef cattle, providing a replicable practical model for smallholder farming systems in developing countries to achieve protein security and livelihood improvement.

CONCLUSION

Animal husbandry is a major source of greenhouse gas emissions. We should focus on knowledge innovation and develop green and low-carbon livestock production technologies. Carbon neutrality is key to controlling global warming, and reducing greenhouse gas emissions can slow the pace of climate change and protect the Earth's ecosystems. Achieving carbon neutrality requires balancing animal production and environmental protection, and promoting sustainable agricultural development.

REFERENCES

Cai, Y., Ataku, K. 2025. *Cultural history and modern production technology of silage*. Springer Nature Singapore.

Du, Z., Fang, J., Pang, H., *et al*. 2025. Utilising rice straw to prepare a culture medium for synthesizing lactic acid bacteria biofilms and regulating silage fermentation. *Bioresource Technology*. 438, 133201.

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