Analysis and forecast of livestock carbon emissions in Henan province

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Abstract. Animal husbandry has become an important global source of anthropogenic greenhouse gases, including carbon emissions from livestock intestinal fermentation and fecal management. This paper systematically analyzed the current situation of carbon emission of livestock husbandry, and the growth curve model, the s-curve model and other time series models were used to simulate and predict the carbon emission of livestock industry in Henan province in the next 10 years.

1. Introduction
At present, most scholars and experts use the method of combining natural science and economic management to try to reveal the complex relationship between carbon emission and energy, economy, society, technology and other aspects from the history of carbon emission, and find the internal laws of greenhouse gas emission reduction and the development of low-carbon economy [1]. Around this core proposition, academic circles have conducted extensive and in-depth studies on the relationship between carbon emission and economic growth [2], estimation and prediction of carbon emission [3], allocation of carbon emission quota [4], path and influence of carbon emission reduction [5], carbon emission intensity [6] and other aspects. But most of the researchers on carbon emissions from the perspective of macro and fuzzy boundary to study, this paper first clear the system boundary of carbon analysis, comprehensively analyzes the current situation of carbon emission and studies its internal laws from a micro perspective.

2. Materials and methods

2.1. Livestock carbon emissions calculation
The livestock carbon emissions is calculated based on the different livestock amount, and carried out according to the carbon emission coefficient method in the IPCC report. The relevant coefficient parameters refer to the guidelines for compiling the provincial greenhouse gas inventory. The carbon emission system of the livestock only contains the carbon emission of the livestock itself.
2.2. Feature analysis
This paper analyzed the characteristics of livestock carbon emission in Henan province from the perspective of time and space, and by the carbon emission intensity index to further analysis. The carbon emission intensity is not in the traditional sense, but the unit carbon emission intensity of different livestock products. The expression is as follows:

\[
Q_{(\text{meat, milk, egg})} = \frac{TC_{(HN, DC, fowl)}}{P_j}
\]

Where, \(Q_{(\text{meat, milk, egg})}\) represents the unit carbon emission intensity of various livestock products (t CO2-eq \cdot t^{-1}); \(P_j\) is the output of livestock products (meat, milk and eggs) at the end of the year (t).

2.3. Forecasting methods
Livestock carbon emission prediction methods include the growth curve model, s-curve model and other time series models. Selected the optimal model according to the fitting results. The simulation is conducted through Minitab 17, Eviews3.1 and Python language.

3. Results and discussion

3.1. Livestock carbon emission characteristics
Livestock carbon emission in Henan province is mainly divided into two stages from 2001 to 2016 (Figure 1). The first stage (2001-2006) is sustained growth; the second stage (2007-2016) is a slow up-and-down stage. Livestock emissions fell rapidly in 2007, followed by a slow rise and fall. Since 2007, livestock carbon emission in Henan province has been growing slowly, and the carbon emission base is smaller than before 2007. Animal husbandry accounts for a large proportion of agriculture, so the impact is obvious. Due to policy adjustment, animal husbandry carbon emissions rose but rose slowly in the later period.

The overall carbon emission of unit livestock products tends to be stable after declining (Figure 2). The lower the carbon emission intensity value per unit of livestock products, the lower carbon emissions per unit of livestock production. The carbon emission intensity of eggs per unit rose slowly. The carbon emission intensity of milk per unit decreased obviously, then increased sharply and gradually leveled off. The livestock carbon emission pattern in Henan province is partially optimized from 2007 to 2018, but it still fails to reach the optimal and stable state.

![Figure 1](image_url). Carbon emission distribution of livestock in Henan province. Cows does not include dairy cow and buffalo.
3.2. Future trends in livestock carbon emissions

The best prediction model is obtained through the calculation and modification of a variety of prediction models. Figure 3 illustrates future carbon emission of different livestock, carbon emission of dairy cow, buffaloes, poultry and pigs have an upward trend (Figure 3(a, c, h, i)). Carbon emission of dairy cow, buffaloes and poultry gradually tends to be stable after 2020, while carbon emission of cows, goats, sheep, horses, donkeys and mules shows a downward trend and gradually tends to be stable. The carbon emission of livestock in Henan province presents a stable trend in the future (Figure 4), and the actual carbon emission fluctuates up and down with the prediction curve.
Figure 3. Forecast trend chart of future carbon emission of different livestock. (b) Cows does not include dairy cow and buffalo.
4. Conclusion

4.1. Different livestock carbon emission contribution rate is different
The large livestock raising quantity is small but the carbon emission is high. The poultry and pig raising quantity are high but the carbon emission is low. The amount of carbon emission generated by different livestock is also different. The main contributor to carbon emission is cattle, among which the carbon emission rate of dairy cows > buffaloes > cows. The second contributor is goat and pig. The amount of large livestock raised determines the carbon emission of animal husbandry under the condition of satisfying human needs. Livestock feeding structure has an important impact on carbon emission of livestock, because the carbon emission contribution rate of different livestock is different, adjusting the livestock feeding structure can effectively reduce the carbon emission base of regional stockbreeding. The Henan provincial government is speeding up the modernization of livestock husbandry. The modernization is combined with the adjustment of animal husbandry feeding structure, it can greatly improve the progress of modernization and the efficiency of carbon reduction.

4.2. Carbon emission from animal husbandry will be stable in the future
Under the current economic policy background, the carbon emission of livestock industry in Henan province is expected to achieve zero growth in 2020. According to the predicted results, the carbon emission of most livestock gradually tends to be stable after a short period of fluctuation. As the country continuously attaches importance to low-carbon economy and low-carbon production, it will promote the early emergence of zero growth of carbon emission of livestock industry.

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