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Influencing Factors and Mechanism of Rural Carbon Emissions in Ecologically Fragile Energy Areas—Taking Ejin Horo Banner in Inner Mongolia as an Example

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Abstract: To achieve carbon neutrality in our country, studying the carbon emissions of rural residents in ecologically fragile energy areas is an important way to scientifically explore a green and low-carbon development mechanism of rural regional systems. Taking Ejin Horo Banner as an example, and based on the survey data drawn from it, this paper analyzes the characteristics and mechanism of carbon emissions in rural regional systems by using the methods of the carbon emissions factor method and multiple stepwise regression. The result showed that: (1) in the total composition of carbon emissions in Ejin Horo Banner, the sources of rural carbon emissions had remarkable characteristics. Energy consumption and livestock and poultry breeding accounted for the largest proportion, 63.89% and 22.72%, respectively. (2) In the family attributes of the rural villages in Ejin Horo Banner, the two factors that had the greatest correlation with the total carbon emissions were age and income. In energy consumption, the largest correlation coefficient with carbon emissions was 0.804 for coal, and the lowest was 0.550 for gasoline. In agricultural inputs, chemical fertilizer had the strongest correlation with carbon emissions, with a correlation coefficient of 0.734, and irrigation had the weakest, with a correlation coefficient of 0.657. In livestock production, cattle had the strongest correlation with carbon emissions, with a correlation coefficient of 0.724. In family life, the factors of daily diet consumption had a strong correlation with carbon emissions, among which the highest was the liquor consumption at 0.784, and the lowest was wastewater treatment at 0.442. (3) The multiple stepwise regression result showed that in the three production and living sectors of energy consumption, agricultural and animal husbandry investment, and household life, 21 factors had a significant predictive power on the carbon emissions in the rural regional systems of Ejin Horo Banner. Through the analysis, it was found that accelerating the popularization of green energy-saving technology, promoting the transformation of rural traditional energy utilization, improving energy efficiency, and advocating a green lifestyle are the important ways to realize rural green development in ecologically fragile energy areas.

Keywords: rural carbon emissions; influencing factors; mechanism; Ejin Horo Banner

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1. Introduction

Climate warming caused by carbon emissions has posed a severe test for social and economic development, as well as ecological security, and the harm of carbon emissions has become one of the major problems that need an urgent solution around the world [1]. In the past 40 years, China's rapid economic development has led to a sharp increase in carbon emissions that have far exceeded the per capita level [2]. It is not conducive to the realization of the carbon peak before 2030 and carbon neutrality before 2060, and thus, it restricts the process of green sustainable development [3,4]. In addition, the acceleration of urbanization, the diminishing of the urban–rural dual structure differences, and the gradual assimilation of rural production and lifestyles by cities and towns have led to an increase in the high carbonization trend of production and life in the rural regional system. With such a huge rural population base in China, the carbon output capacity cannot be underestimated. In the context of the national efforts to achieve carbon neutrality, which requires energy conservation and emissions reduction, reducing carbon emissions in rural production and life and clarifying the influencing factors and mechanism of carbon emissions in rural regional systems have become a difficult and hot issue in the realization of the national carbon emissions reduction tasks, accelerating rural high-quality revitalization, and building the beautiful countryside. The research has strong practical significance.

Human activities are an important part of the driving factors of carbon emissions [5]. Scholars have conducted some accounting, evaluation, and prediction of the single-factor carbon output level in rural human activities, such as agricultural production, livestock and poultry breeding, and agricultural land use. The result showed that carbon emissions from rural production and life was one of the major sources of global greenhouse gases [6–8]. Therefore, more attention should be paid to the carbon emissions in rural regional systems, and it is also necessary to clarify its characteristics and influencing factors. However, due to limited data access, the research on carbon emissions in rural regional systems at home and abroad is less concerned. Chinese and foreign scholars mainly discussed this issue from the following aspects. Firstly, they made it clear that carbon emissions had a strong link with agricultural production activities, such as agricultural waste treatment [9], agricultural input [10], and land use conversion [11]. Secondly, they analyzed the carbon emissions of different kinds of agricultural production activities, such as animal husbandry [12–14] and farming [15–17]. Thirdly, from the perspective of agricultural systems and agricultural science and technology, they made a systematic explanation of how to reduce carbon emissions [18–20]. Overall, there are many research results on single-factor carbon emissions within the rural regional systems, and most of them focus on the carbon emissions of agricultural production. The lack of research on carbon emissions output related to rural life and production leads to an incomplete construction of the carbon emissions mechanism in rural regional systems. This paper takes the ecologically fragile energy region as the research object. There are many complex sources of carbon emissions from rural production and living systems in this region, which is an ideal case in which to explore such issues. On the basis of the carbon emissions accounting of the rural regional system, the aim is to fully clarify their influencing factors, innovate and build the carbon emissions mechanism of the rural regional system, and lay a solid foundation for guiding rural carbon emissions reduction in ecologically fragile areas and for scientifically alleviating the contradiction between rural production and living and the carbon emissions output.

Ejin Horo Banner is in the core of the energy area consisting of Hohhot, Baotou, Ordos, and Yulin. Blessed with abundant energy resources, it is the third largest coal-producing county and an important national energy strategic base. The long-term exploitation of energy and mineral resources has caused regional ecology destruction and made the issue of carbon emissions more prominent. In the crucial phase of national energy conservation and emissions reduction, it is more urgent to explore the problems of carbon emissions in the rural regional systems of energy development zones. Based on field investigation and questionnaire survey data, this research uses the carbon emissions coefficient method, the mathematical statistics analysis method, and the factor analysis method to analyze the characteristics and influencing factors of carbon emissions in rural regional systems of energy-rich areas, so as to reveal systematically the mechanism of carbon emissions systems in rural production and life and provide reference for formulating methods of carrying out rural energy conservation and emissions reduction.

2. Materials and Methods

2.1. Study Area

Ejin Horo Banner (108°58′ E~110°25′ E, 38°56′ N~39°49′ N) is in the south-central part of Ordos city. By the beginning of 2020, its population was 263,000 [21]. As one of the important strategic bases of energy and mineral resources in the country, Ejin Horo Banner owns 103 discovered mineral deposits of different types. By virtue of the rich resources, its county-level economic comprehensive competitiveness in 2020 ranked 20th in the top 100 counties of the country and is a strong engine driving regional development. Ejin Horo Banner has a strong economic strength, a solid industrial foundation, superior development conditions, and a perfect modern industrial system. However, years of mineral exploitation has also led to environmental degradation and a fragile ecological environment. As carbon emissions play an important role in maintaining a stable ecological environment, reversing their rising trend is an effective way to reduce the risk of ecological environment destruction. This paper, from the perspective of carbon emissions in the production and life of rural residents in Ejin Horo County, provides an accounting of the carbon emissions and explores their formation mechanism to provide scientific reference for the inhibiting of rural carbon emissions in ecologically fragile energy areas and alleviating the deterioration of the ecological environment.

2.2. Data Sources and Processing

On selecting Ejin Horo Banner as the object, after considering the economic development, social culture, ecological environment, resource endowment, and other factors, 22 gacha (villages) were investigated by a stratified sampling method, basically covering the whole Ejin Horo Banner. The questionnaire mainly involved four parts: family basic information, energy utilization, production, and daily life. After summarizing and screening valid questionnaires, the response rate of the questionnaires reached 92%.

The sample age was mainly concentrated on the group aged over 50 years old, which accounts for 86.99% of the total sample, and the group aged under 50 years old, which accounts for 13%, demonstrating the age structure of the rural population. In addition, their education level and income level were low; only 37.57% had received junior high school education or above, and as much as 40.35% of the families had a monthly income below CNY 1700. Such groups are highly dependent on the original energy and may be a main source of carbon emissions in production and in life, while having a weak awareness of cutting carbon emissions.

2.3. Carbon Sources Identification

Based on the field investigation, the carbon sources in the rural regional systems of Ejin Horo Banner were identified and divided into four dimensions: family, life, agriculture and animal husbandry, and energy, which contained 33 specific carbon sources (Table 1).

Table 1. Rural area system carbon source of Ejin Horo Banner.

Rural Regional System	Carbon Source Name
Family population	Demographic attribute
Living consumption	Food, Meat, Clothing, Smoking, Beer, Liquor, Washing powder, Plastic bags, Disposable chopsticks, Trip distance, Waste, Wastewater
Agricultural and animal husbandry production	Fertilizers, Plastic film, Pesticides, Tillage, Irrigation, Non-dairy cow, Mule/donkey, Pig, Sheep, Poultry
Energy consumption	Coal, Gasoline, Diesel fuel, LPG, Electricity, fuelwood

2.4. Carbon Emissions Accounting

According to the identification results of the carbon sources in Ejin Horo Banner, the carbon emissions coefficients corresponding to carbon sources were discovered, and the carbon sources were converted into carbon emissions, and then, an accounting of the carbon emissions of the rural regional systems was conducted [22–32]. The specific formula is as follows (Table 2).

Table 2. Calculation formula table of rural carbon emission.

Index	Formula	Variable Explanation
Population carbon emissions	$C = P \times 0.9$	C is carbon emissions, P is the number of the family population, and 0.9 kg is carbon emissions per person per day.
Traditional energy carbon emissions	$C = F \times q$	C is carbon emissions, F is energy consumption, and q is carbon emissions coefficient.
Clean energy carbon emissions	$C = NCV \times EF$	C is power carbon emissions coefficient, NCV is power low heating value, and EF is power baseline factor.
Household carbon emissions	$C = N \times q$	C is carbon emissions, N is indirect carbon emissions usage, and q is carbon emissions coefficient.
Agricultural carbon emissions	$C = Q \times q$	C is carbon emissions, Q is agricultural input, and q is carbon emissions coefficient.
Livestock and poultry Breeding carbon emissions	$C = M \times q$	C is carbon emissions, M is the quantity of livestock and poultry breeding, and q is the carbon emissions coefficient (CH_4 and N_2O are converted into carbon emissions, and the GWP coefficients are 21 and 310, respectively).
Transport carbon emissions	$C = K \times q$	C is carbon emissions, K is the energy consumption of vehicles, and q is the carbon emissions coefficient of vehicles.
Waste carbon emissions	$ECO_2 = å(IW \times CCW \times FCF \times EF \times 44/12)$	ECO2 refers to the carbon emissions from waste incineration; IW is the amount of waste; CCW refers to the proportion of carbon content; FCF refers to the proportion of mineral carbon in total carbon of waste; EF is combustion efficiency; and 44/12 is the conversion coefficient between carbon and carbon dioxide.
Wastewater carbon emissions	$ECO_2 = W \times EF \times CE$	ECO_2 refers to carbon emissions from rural domestic sewage; W is the amount of rural sewage; EF is the power consumption coefficient of sewage treatment, referring to the regional power baseline factor; and CE is the power consumption per cubic meter, and this research takes the average value of 0.3 KWh/m^3 from its general value range of 0.2–0.4 KWh/m^3.

3. Results

3.1. Rural Carbon Emissions Accounting

The accounting of the output of the carbon emissions from the different sectors in the villages (Table 3) conducted through the formula in Table 2. It can be seen from Table 3 that the average amount of carbon emissions of the surveyed villages was 310.65 t, among which 10 villages produced much more carbon than the average amount, accounting for 45.45% of the total. The carbon emissions from energy consumption and livestock and poultry breeding took up more than 80% of the total carbon emissions, indicating that these two were the main sources of carbon emissions from production and life in the rural regional systems of Ejin Horo Banner, and the overall level of carbon emissions there was high.

Table 3. Carbon emissions in the rural sector.

Name of Village	Energy Carbon Emissions (t)	Biomass Energy (t)	Household Life (t)	Agricultural Production (t)	Livestock and Poultry Farming (t)	Transportation (t)	Wastewater (t)	Total Amount (t)
Chagan Chaidamu	166.73	9.67	7.75	5.83	52.35	0.24	0.28	242.85
Quanhechang	199.46	6.86	9.6	8.19	34.24	0.19	0.47	259.01
Huyagetu	146.56	8.23	7.11	10.86	152	0	1.12	325.88
Xinmiao	110.91	0	7.77	0	0.03	0.11	0.27	119.09
Manlai	198.67	0	8.69	0.05	4.86	0	0.3	212.57
Naoerhao	258.08	7.54	7.12	7.51	73.66	0.39	0.19	354.49

Table 3. *Cont.*

Name of Village	Energy Carbon Emissions (t)	Biomass Energy (t)	Household Life (t)	Agricultural Production (t)	Livestock and Poultry Farming (t)	Transportation (t)	Wastewater (t)	Total Amount (t)
Hongqinghe	125.39	14.05	8.27	10.45	57.51	0	0.2	215.87
Baolin	191.48	20.4	7.8	10.07	101.96	0.05	0.23	331.99
Naringhiri	309.29	9.26	9.19	8.92	139.78	0.1	0.24	476.78
Qigengou	178.09	25.23	8.68	6.91	103.77	0.04	0.2	322.92
Fengjiaqu	196.94	19.54	10.83	14.22	101.12	0	0.24	342.89
Muhuaobao	150.97	18.51	8.91	12.27	29.52	0	0.32	220.5
Taige Hilli	183.09	18.17	10.8	18.03	69.19	0.04	0.29	299.61
Gaole Temple	165.8	14.4	7.65	6.63	39.21	0.03	0.27	233.99
Maleqing Haolai	200.39	10.63	6.13	5.04	23.72	0	0.2	246.11
Huanggaishili	175.13	24	8.9	13.13	51.44	0.11	0.23	272.94
Harimhur	216.39	8.74	8.98	2.6	21.18	0.23	0.28	258.4
Baga Qaidam	241.89	30.51	14.21	31.26	176.33	0	0.77	494.97
Taige Gacha	234.37	17.14	13.3	65.85	144.67	0.14	0.32	475.79
Shuhao	245.32	19.2	6.46	8.65	59.33	0	0.21	339.17
Chagannur	416.32	14.74	12.87	7.29	76.17	0	0.27	527.66
Yellow Tolgoi	188.64	12	9.27	9.68	40.82	0.14	0.23	260.78

3.2. Structure and Causes Analysis of Rural Carbon Emissions

According to the formula in Table 2, the carbon emissions of the different sectors in the rural regional systems of Ejin Horo Banner are accounted for.

According to Table 4, the total amount of rural carbon emissions in Ejin Horo Banner is 7041.548 t, and the average household and per capita carbon emissions are 31.58 t/h and 11.16 t/p, respectively. In the total composition, carbon emissions from energy consumption take up the largest part, with a total amount of 4499.94 t, of which the carbon emissions from fossil energy account for 41.00% and those from clean energy (1612.47 t) account for 22.89%. The second largest part is found in livestock farming, accounting for 22.72% of the total, whereas the carbon emissions from biomass energy, agricultural production, and family life account for a relatively small proportion at 4.52%, 3.85%, and 2.93%, respectively. Coal makes up the largest part of the carbon emissions from energy consumption, indicating that rural production and life in Ejin Horo Banner are highly dependent on primary energy, which is not conducive to carbon emissions control. The reason is that the rural residents, who are mostly aged, poorly educated, and have limited access to information, tend to be less accepting of new energy, and resort to traditional energy and fossil energy resources that are easily accessible and simple to use. Other reasons, such as the inefficient management of agricultural production and livestock and poultry breeding, single modes of production, improper waste treatment, and the lack of environmental protection promotion also account for the high carbonization of its carbon emissions structure.

Table 4. Total carbon emissions.

Project	Carbon Emissions (t)
Resident	207.28
Energy consumption	4499.94
Biomass	308.79
Family life	200.29
Agricultural Production	263.44
Livestock and poultry farming	1552.87
Transportation	1.81
Wastewater	7.128
Total carbon emissions	7041.548

Table 4. *Cont.*

Project	Carbon Emissions (t)
Household average	31.58
Per capita	11.16

3.3. Correlation Analysis of Influencing Factors of Rural Carbon Emissions

SPSS software was used to analyze the correlation between carbon emissions, with five dimensions: household composition, energy utilization, agricultural production, animal husbandry production, and family life. The results are shown in Table 5.

Table 5. Carbon Emissions Correlation.

Carbon Emissions Type	Factors	Correlation Coefficient
Total carbon emissions	Age	−0.522 **
	Monthly household income	0.500 **
	Housing area	0.462 **
	Family population	0.420 **
	Education level	−0.218 **
Energy carbon emissions	Coal	0.804 **
	Diesel fuel	0.745 **
	Electricity	0.627 **
	Gasoline	0.550 **
Agriculture and animal husbandry carbon emissions	Fertilizer	0.734 **
	Pesticide	0.657 **
	Tillage	0.663 **
	Irrigation	0.663 **
	Cattle	0.724 **
	Sheep	0.720 **
	Pig	0.604 **
Household carbon emissions	Liquor	0.784 **
	Meat	0.772 **
	Food	0.760 **
	Clothing	0.486 *
	Washing powder	0.467 *
	Wastewater	0.442 *

** In Significant correlation at level 0.01 (bilateral), * Significant correlation at 0.05 level (bilateral).

It can be seen from Table 5 that the factor that makes the family attributes most correlated with total carbon emissions is age, at −0.522, which is negatively correlated. It indicates that the older a person is, the less he contributes to the total carbon emissions, as this kind of group is at a lower consumption level and thus has a weaker demand for carbon emissions. The correlation coefficient between monthly household income and total carbon emissions is 0.500, indicating that an increase in income will lead to the growth of carbon emissions demand. In family attributes, the factor least correlated with total carbon emissions is the education level at only −0.218. However, existing studies have proved that education level can directly affect carbon output [33]. Yet, as the residents in the surveyed villages are generally poorly educated, the impact of education level on carbon emissions reduction is weak. Energy consumption has a strong correlation with total carbon emissions, and the largest correlation coefficient index is coal at 0.804, and the lowest correlation coefficient index is gasoline at 0.550, indicating that the rural residents have a huge demand for and consumption of coal, which is also related to the easy availability of regional coal resources. As Ejin Horo Banner is in the farming–pastoral ecotone and has made a huge input in this sector, the correlation between the input of each factor and the carbon emissions output is also strong. In agricultural input, the factors that correlate with carbon emissions from the strongest to the weakest are chemical fertilizer, pesticide, tillage, and irrigation, with the correlation coefficients of 0.734, 0.663, 0.663, and 0.657, respectively. In livestock production, the factors that correlate with carbon emissions from the strongest to the weakest are cattle, sheep, and pigs, with the correlation coefficients of 0.724, 0.720, and 0.604, respectively. In household life, the factors of daily diet consumption have a strong correlation with carbon emissions, among which the highest is liquor consumption at 0.784, and the lowest is wastewater treatment at 0.442.

3.4. Regression Analysis of Carbon Emissions from Production and Life

Through the above analysis, it was found that the factors of rural production and life are correlated with carbon emissions to different degrees. Based on this, this paper constructs the carbon emissions output model of various factors in rural production and life by using the stepwise regression method and eliminating falsely related factors. The regression results are shown in Table 6.

Table 6. Carbon Emissions Multiple Regression Analysis.

	Stepwise Regression	R	R^2	DR^2	F	Net F Value	B	β	Deviatoric
Energy consumption	Intercept						0.919		
	Coal	0.692 [a]	0.478	0.476	202.632 ***	202.632 ***	0.002	0.541	0.978
	Diesel	0.894 [b]	0.799	0.798	438.247 ***	352.018 ***	0.003	0.559	0.981
	Electricity	0.981 [c]	0.963	0.963	1908.809 ***	973.887 ***	0.004	0.379	0.956
	Gasoline	0.994 [d]	0.987	0.987	4205.551 ***	409.677 ***	0.003	0.163	0.817
	Fuelwood	0.994 [e]	0.988	0.988	3511.932 ***	10.422 *	0	0.024	0.214
Agricultural inputs	Intercept						0.007		
	Cattle	0.753 [a]	0.568	0.566	290.211 ***	290.211 ***	1.724	0.68	1
	Sheep	0.991 [b]	0.981	0.981	5741.360 ***	4839.164 ***	0.215	0.584	1
	Fertilizers	0.999 [c]	0.998	0.998	39,292.599 ***	2001.107 ***	0.001	0.138	0.995
	Pigs	1.000 [d]	1	1	471,584.664 ***	3280.451 ***	0.153	0.045	0.974
	Plastic film	1.000 [e]	1	1	461,585.814 ***	49.717 ***	0.005	0.005	0.451
	Poultry	1.000 [f]	1	1	453,806.404 ***	40.008 ***	0.003	0.004	0.353
	Pesticides	1.000 [g]	1	1	401,343.694 ***	7.867 *	0.006	0.003	0.188
Household life	Intercept						0.004		
	Food	0.833 [a]	0.693	0.692	497.107 ***	497.107 ***	0.001	0.499	0.985
	Liquor	0.955 [b]	0.913	0.912	1147.415 ***	552.214 ***	0.002	0.464	0.987
	Meat consumption	0.990 [c]	0.98	0.98	3555.843 ***	730.326 ***	0.002	0.267	0.956
	Beer	0.994 [d]	0.989	0.988	4723.898 ***	165.760 ***	0	0.089	0.779
	Clothing purchase	0.997 [e]	0.993	0.993	6294.893 ***	143.806 ***	0.006	0.067	0.642
	Electric vehicle Travel	0.997 [f]	0.994	0.994	6135.152 ***	37.366 ***	0	0.031	0.393
	Garbage	0.997 [g]	0.995	0.995	5770.097 ***	21.781 ***	0	0.024	0.295
	Disposable Chopsticks	0.998 [h]	0.995	0.995	5349.551 ***	13.674 ***	0	0.015	0.197
	Laundry powder	0.998 [i]	0.995	0.995	4855.156 ***	5.452 *	0.001	0.014	0.158

[a–i] Predictive variables; * $p < 0.05$, *** $p < 0.001$.

Through stepwise multiple regression analysis, it was found that five factors in energy consumption have remarkable predictive power, namely coal, diesel, electricity, gasoline, and fuelwood. Seven factors in agricultural inputs have significant predictive power, namely cattle, sheep, fertilizers, pigs, plastic film, poultry, and pesticides. Nine factors in household life have significant predictive power for agricultural inputs, namely food, liquor, meat consumption, beer, clothing purchase, electric vehicle travel, garbage, disposable chopsticks, and laundry powder. The regression results show that R^2 is greater than 0.988 and passes the overall test. The explanation of the variations is also more than 98.8%. Therefore, the regression results are ideal, and the model fitting effect is good enough to construct the regression model. The three standardized regression models are:

Carbon emissions from energy utilization = 0.541 × coal + 0.559 × diesel + 0.379 × electricity + 0.163 × gasoline + 0.024 × fuelwood.

Carbon emissions from agricultural and animal husbandry input = 0.680 × cattle + 0.584 × sheep + 0.138 × chemical fertilizer + 0.045 × pig + 0.005 × plastic film + 0.004 × poultry + 0.003 × pesticide.

Household carbon emissions = 0.499 × grain + 0.464 × liquor + 0.267 × meat + 0.089 × beer + 0.067 × clothing purchase + 0.031 × electric vehicle travel + 0.024 × garbage + 0.015 × disposable chopsticks + 0.014 × laundry powder.

3.5. Formation Mechanism of Rural Carbon Emissions

The carbon emissions in the rural regional systems of ecologically fragile energy development zones are affected by multiple factors. The four dimensions of family, energy, agriculture and animal husbandry, and life have exerted long-term impacts on carbon emissions, constituting a unique mechanism of carbon emissions (Figure 1). Among them, the educational level, economic conditions, and age structure of family members directly affect the generation of rural carbon emissions, and a certain family type has strengthened the production and lifestyles. Therefore, family composition is the fundamental driving force of rural carbon emissions. The dependence on traditional energy accelerates the generation of carbon emissions in rural regional systems and thus is the core factor of rural carbon emissions sources. Agriculture and animal husbandry, as an important part of rural life, exacerbates rural carbon emissions due to their extensive production processes and unreasonable resource utilization. In addition, the weak awareness of leading a clean life and the widespread high-carbon lifestyles have deepened the mode of rural carbon emissions. All in all, the rural carbon emissions mechanism is complex, and the family structure, energy utilization, and the production and lifestyles of agriculture and animal husbandry are closely intertwined and have all played a part in forming a unique rural carbon emissions mechanism in ecologically fragile energy areas.

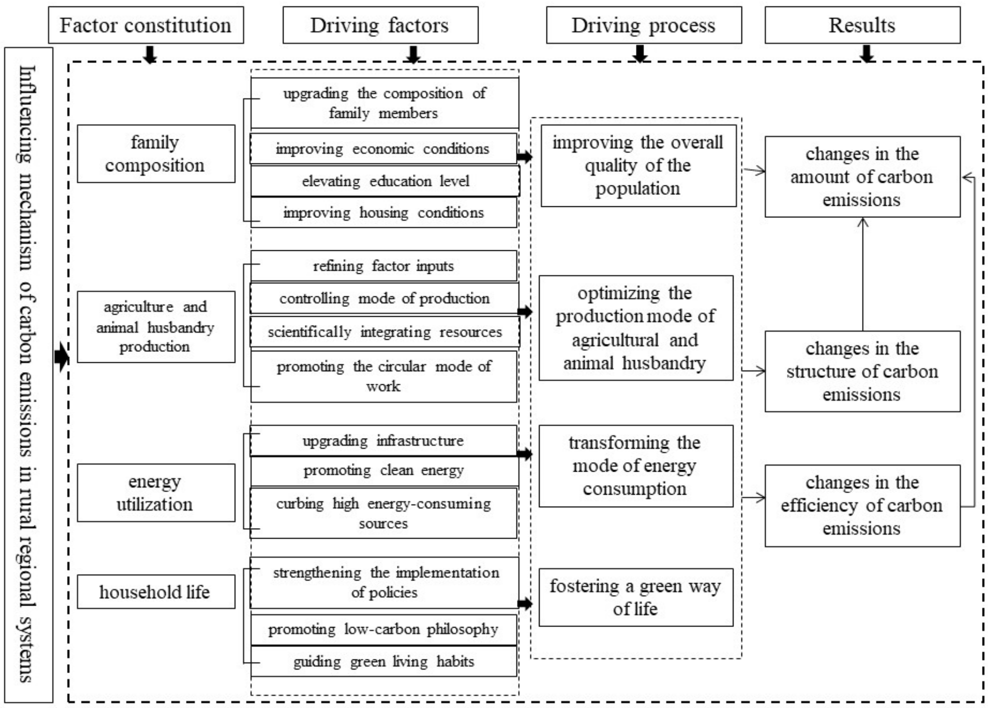

Figure 1. Mechanism of carbon emissions in rural areas.

4. Discussion

Based on field research, this paper explored the rural carbon emissions in small-scale regional units by using a carbon emissions coefficient method and a mathematical statistics analysis method and is of great reference value for the implementation of energy conservation and emissions reduction in small-scale ecologically fragile areas. Through the accounting of the carbon emissions in rural systems of ecologically fragile areas and discussing the mechanism of carbon emissions in rural regional systems, the paper provides four ways that can effectively reverse the trend of high carbonization in rural areas. First, the region should improve the existing living conditions, eliminate high-energy patterns of household energy consumption, accelerate infrastructure construction, and popularize the utilization of clean energy to gradually abandon the existing high-carbon lifestyle. Second, it should improve the science and technology level of agricultural production, speed up the research and development of drought-resistant and insect-resistant crops, and accurately control agricultural input factors to make scientific irrigation and plowing, actively integrate agricultural land resources, and use efficient agricultural machinery and equipment to avoid repeated carbon emissions. Third, it should integrate animal husbandry resources by making an efficient use of animal husbandry waste so as to develop a circular farming mode and thus reduce the sources of carbon emissions. Fourth, it should improve the system of carbon emissions supervision and strengthen rural residents' awareness of energy conservation and emissions reduction, while also guiding them to form good habits that can optimize the carbon emissions structure and reduce the total amount of carbon emissions. Based on the field survey data, the paper only preliminarily discusses the characteristics and mechanism of carbon emissions in the rural areas of Ejin Horo County, while lacking a long-term follow-up survey. In the following research, the study will be further completed by strengthening the follow-up survey of specific villages and widening the dimensions of carbon emissions in rural regional systems to explore a deeper carbon emissions mechanism of rural regional systems.

5. Conclusions

Based on the field investigation and the questionnaire survey data, this paper conducted a carbon emissions factor method and a correlation analysis method to account for the carbon emissions from different dimensions in the rural regional systems of Ejin Horo Banner. Through correlation analysis and regression analysis, the regression models of different carbon emissions sectors are constructed, and therefore, the carbon emissions mechanism of rural regional systems in Ejin Horo Banner is built. The study provided practical reference for the government of Ejin Horo Banner to formulate the implementation path of rural energy conservation and emissions reduction. The main conclusions are as follows:

(1) The average household and per capita carbon emissions in Ejin Horo Banner are 31.58 t/h and 11.16 t/p out of the total 7041.548 t. In the total composition of carbon emissions, the main sources of rural carbon emissions are, remarkably, from energy consumption and livestock and poultry breeding, which account for 63.89% and 22.72%, respectively, which shows that the rural regional systems of Ejin Horo Banner are highly dependent on energy, especially high energy-consuming sources of fossil energy that account for 41% of energy consumption.

(2) In the family attributes in villages of Ejin Horo Banner, the two factors mostly correlated with total carbon emissions are age and income level, whose correlation coefficients are –0.522 and 0.500, whereas the factor least correlated with total carbon emissions is education level, whose correlation coefficient is -0.218. Energy consumption has a strong correlation with total carbon emissions, with the largest correlation coefficient of 0.804 for coal and the minimum correlation coefficient of 0.550 for gasoline, indicating that the rural residents have a huge demand and consumption of coal; this is also related to the easy availability of regional coal resources. In agricultural input, the factors that correlate with carbon emissions from the strongest to the weakest are chemical fertilizer, pesticide, tillage, and irrigation, with the correlation coefficients of 0.734, 0.663, 0.663, and 0.657, respectively; in livestock production, the factors that correlate with carbon emissions from the strongest to the weakest are cattle, sheep, and pigs, with the correlation coefficients of 0.724, 0.720, and 0.604, respectively; and in household life, the factors of daily diet consumption have a strong correlation with carbon emissions, among which the highest is liquor consumption at 0.784, and the lowest is wastewater treatment at 0.442.

(3) After multiple stepwise regression analysis of carbon emissions factors in rural regional systems, it was found that five factors in energy consumption have significant predictive power, namely coal (0.541), diesel (0.559), electricity (0.379), gasoline (0.163), and fuelwood (0.024). Seven factors in agricultural inputs have significant predictive power for agricultural inputs, namely cattle (0.680), sheep (0.584), fertilizers (0.138),

pigs (0.045), plastic film (0.005), poultry (0.004), and pesticides (0.003). Nine factors in family life have significant predictive power, namely grain (0.499), liquor (0.464), meat consumption (0.267), beer (0.089), clothing purchase (0.067), electric vehicle travel (0.031), garbage (0.024), disposable chopsticks (0.015), and laundry powder (0.014).

(4) The characteristics and mechanism of carbon emissions in the rural regional system are affected by many factors, such as family, energy, agricultural and animal husbandry, and life; thus, the carbon emissions have the typical characteristics of the rural regional system. Family composition is the fundamental driving force of carbon emissions in rural regional systems, and agricultural and animal husbandry production, energy utilization, and family life are also the factors that influence carbon emissions in rural regional systems of energy development zones. Altering the existing production and lifestyles through scientific and technological innovation is an important way to adjust the existing carbon emissions in rural regional systems.

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