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A Research on Different Types of Household Energy Consumption in the Rural Areas under the background of New Urbanization

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ABSTRACT

Urbanization is the inevitable result of economic development and social progress. China's urbanization is entering a period of rapid development. In the new urbanization construction, the economic development will inevitably lead to the upgrading and optimization of energy industry. In this paper the study applies multiple linear regression model to analyze the influencing factors of different types of energy consumption in the process of urbanization. The results show that: labor transfer has a significant effect on the energy consumption of different household combinations; household income, family size, household age and household education level all have a certain impact on the energy consumption of rural households. The availability of energy has a certain impact on the energy consumption of rural households; the consumption willingness of farmers affecting its energy consumption.

Keywords: *new urbanization; rural energy; consumption*

INTRODUCTION

In the 21st century, China's rapid urbanization process has provided a powerful impetus to the social and economic development. With the advancement of functions of the major cities in the country, the continuous improvement of the level of urban and rural integration, the continuous strengthening of regional urbanization effect, China's urbanization has entered a new stage in which economic, social, cultural and political maintain comprehensive, coordination and sustainable development, urban and rural areas are integrated. The report of the 16th National Congress of the Communist Party of China made it clear that "taking the road of urbanization with Chinese characteristics" and that was an important symbol of China's traditional urbanization into the development of new urbanization. The report of the 18th National Congress of the Communist Party of China stressed that urbanization will become an important carrier of China's comprehensive construction of a well-off society, and it is the greatest potential for leveraging domestic demand. The new type of urbanization requires the adoption of intensive, intelligent, green and low-carbon ecological methods and technology for the rational planning of energy utilization and ecological environment construction. Strengthening the rural energy and ecological construction has become an important part of the new urbanization process. Economic development will inevitably lead to a substantial increase in the demand for energy industry, and as the key object of urbanization construction in China, the development and effective utilization of rural energy are also important [1].

Rural energy is the material basis for building a well-off society in an all-round way. Rural energy consumption is related to the development of rural agricultural production, the improvement of rural living standards and the improvement of the overall rural environment [2]. With the continuous development of economy, the consumption of rural energy has entered a stage with large demand, and the total

consumption is increasing year by year. Rural areas have long been affected by economic and technological level and traditional farmers' awareness. They have to rely on locally more accessible energy, which makes farmers rely too much on inefficient traditional biomass energy such as rice straw and firewood, and use less commodity energy and new energy. However, the initial cost of electricity, biogas and solar energy is too large to restrict their use. With the development of renewable energy, coal, liquefied petroleum gas and diesel charcoal have been replaced by renewable energy sources such as biogas and straw, and the calorific value and price of these fuels are also low [3]. At the same time, excessive firewood in rural areas will lead to the destruction of the ecological environment, equally, the inadequate and unreasonable use of energy will produce a lot of pollutants and waste. All these indicate that the development of rural economy and environment is facing great pressure [4]. With the development of China's rural economy, considering the development trend of China's energy, the traditional energy production and consumption makes rural energy consumption become the main source of future carbon emission in China, which cannot guarantee the sustainable development of China's economy and environment [5]. The choice of low-carbon energy for sustainable development is a huge challenge for rural energy.

RESEARCH AREAS AND DATA SOURCES

Research Area Profile

The research area of this paper is Shaanxi province and Henan province, and the subjects are farmers in two provinces. In order to get more comprehensive and intuitive understanding of labor transfer and the status of farmers' energy consumption of the two provinces, the data of Shaanxi Province and Henan Province were respectively and statistically analyzed, and then the aggregated data from the two provinces were analyzed on the descriptive analysis. Specific results are as follows:

Table1. *Survey the basic situation of farmers in the region*

	Shaanxi Province (N=288)	**Henan Province (N=380)**	**Total (N=668)**
	Mean (Standard deviation)	Mean (Standard deviation)	Mean (Standard deviation)
family resident population (number)	2.94 (1.21)	2.84 (1.19)	2.88 (1.20)
labor transfer populatio (number)	1.09 (0.97)	1.14 (0.91)	1.12 (0.94)
total area of cultivated land (mu)	7.14 (6.97)	5.75 (3.10)	6.35 (5.18)
household net income (yuan)	33620.44(32579.57)	40929.45 (28285.14)	37778.26 (30404.59)
agricultural net income (yuan)	11647.83(24094.28)	14466.56 (16756.26)	13251.30 (20280.18)
labor transfer net income (yuan)	13581.60(16321.69)	17047.63 (17104.39)	15553.29 (16846.81)
firewood (Kgce)	544.47 (760.15)	376.07 (460.75)	448.67 (613.37)
straw (Kgce)	393.22 (476.99)	560.75 (553.43)	488.52 (528.04)
liquefied gas (Kgce)	2.08 (5.02)	2.07 (4.31)	2.08 (4.63)
electricity (Kgce)	398.08 (292.78)	488.31 (373.73)	449.41 (343.87)
biogas (Kgce)	5.34 (1.11)	4.50 (43.09)	4.55 (41.84)
solar energy (Kgce)	6.00 (16.38)	1.04 (1.23)	2.30 (8.57)
coal (Kgce)	238.54 (438.66)	89.76 (305.57)	153.90 (375.89)
total energy consumption (Kgce)	1579.50 (1045.12)	1522.50 (832.90)	1547.08 (930.04)

Table 1 shows the basic situation of farmers in the study area. We can see from the data in the table that compared with Shaanxi province, Henan has fewer permanent residents and a large number of labor force transfer, but the household income, agricultural income and labor transfer income of Henan province are all higher than that in Shaanxi province. It can be seen that labor transfer has a certain impact on the income situation of farmers; In terms of energy consumption, Henan province which has a large number of labor force transfer has a relatively small amount of energy consumption compared with Shaanxi province. In the total amount of energy consumption in Henan province, the use of firewood, liquefied gas, methane, solar energy and coal is relatively small, and the use of straw and electricity is more. It can see there is a certain impact between the number of labor transfer and the energy consumption; The more Cultivated land area, the more straw used by the farmers, and there is a direct link between them.

From the percentage of energy consumption, we can see that firewood, straw, electricity and coal are the main energy consumed in the production and daily life of farmers. Among the four major energy consumption, firewood consumption accounted for 28.96%, straw accounted for 31.53%, electricity accounted for 29% and coal consumption accounted for 9.93%. It is clear that farmers in the two provinces are more likely to use biomass energy and low-quality commodity energy. Due to the high initial cost of solar energy and biogas, the use of these energy sources is restricted by economic conditions.

Data Sources

The questionnaire of this paper mainly adopts the method of sampling survey and one to one household survey. The questionnaire mainly includes the following eight parts,

- The basic situation of the family,
- Family capital situation,
- Family production behavior, working behavior and working decision-making,
- Household energy consumption behavior,
- Evaluation of biogas,
- Evaluation of solar energy,
- Energy consumption concept,
- Willingness and behavior.

The first three parts of the questionnaire are about basic family situation, family capital and family production behavior. From this, we can obtain data information such as the age of household head, the main occupation of the household, the marital status of the household, the education level of the household, the family resident population, the family location, the cultivated land, income information and so on. From the fourth part of the questionnaire which is related to working behavior and working decision, we can get the information such as the number of rural labor force transfer, occupations, time, places, access route, income and working decision. From the fifth, sixth, seventh part of the questionnaire of household energy consumption behavior and the evaluation of biogas and solar energy, we can get the information about the usage amount and price of seven energy sources that use of farmers daily life, and these seven kinds of energy sources include firewood, straw, liquefied petroleum gas, electricity, biogas, solar energy and coal. From the eighth part of the questionnaire which is related to energy consumption concepts of residents, willingness and behavior of farmers, the data of farmers' willingness to consume are obtained.

Variable Setting and Research Methods

Variable Settings

Independent variable: The number of labor transfer; Per capita labor transfer income; The occupation of backflow labor force; Dependent variable: Per capita consumption of energy, per capita non-commodity energy consumption; Per capita consumption of conventional energy, per capita new energy consumption; Per capita renewable energy consumption, per capita non-renewable energy consumption; Per capita clean energy consumption, per capita pollution energy consumption;

Control variable: Per capita agricultural net income; household population size; the age of household head; the education level of the household; Per capita cultivated land area; Distance to the highway; Willingness to consume.

Research Methods

In this paper, we use multiple linear regression model to analyze the influencing factors of farmers' different energy consumption, and use regression analysis results of the empirical model to test whether the research hypothesis proposed in this paper is passed. This paper use stata10.0 for statistical analysis.

Results and Analysis

Descriptive Statistical Results

From the analysis of the results in Table 2, basically, each family has 1 person labor transfer behavior. It shows that the phenomenon of labor transfer is universal. The per capita income of labor is higher than that of per capita agricultural income. It seems that the importance and status of agricultural income in the family are gradually reduced and replaced by the non-agricultural income. The duration of education for the head of household is essentially 8 to 9 years; The age of the householder is around 50 years old, and the rate of acceptance of advanced knowledge and ideas is slower for the elderly; The number of backflow labor occupations is 3, indicating that

the labor force after the return is more engaged in agriculture and less engaged in industry and service; The number of consumer willingness is 2, indicating that people tend to use electricity, coal and other conventional commodity energy, and the preferences of use new energy such as fuelwood, straw biomass and solar energy is poor; There is a large standard deviation among these three variables, per capita labor transfer income, per capita agricultural net income and the distance between the road, which indicates that the data changes to a certain extent and is unstable.

Table2. *Argument Description Statistical Analysis (N668)*

Variable	Mean	Standard Deviation	Minimum Value	Maximum Value
number of transferred labor force (number)	1.12	0.94	0	5
per capita labor transfer income (yuan / year)	10190.62	13213.62	0	100000
per capita agricultural net income(Yuan / year)	8319.82	17165.06	0	370000
family size (number)	2.88	1.20	1	6
per capita arable land (year)	48.80	10.73	21	77
the education level of the household (year)	8.64	2.99	0	16
per capita arable land (mu)	2.51	2.10	0	18
distance to the highway (meter)	95.85	294.92	0	2510
electricity price (yuan / degree)	0.55	0.05	0.45	0.80
	Mode	Standard deviation	Minimum Value	Maximum Value
backflow labor force occupation	3	0.94	1	3
consumption preferences	2	0.64	1	3

A series of data characteristics of the dependent variable are given in Table 2.From the table, we can see that farmers use more non-commodity energy than commercial energy; Farmers use more conventional energy than new energy; Farmers use more renewable energy than non-renewable energy; Farmers use more polluting energy sources, and clean energy is used less. In addition to new energy sources, the standard deviation of the remaining energy consumption is large, and the data stability is poor.

Table3. *Dependent variable descriptive statistical analysis (N668)*

Dependent variable	Mean	Standard Deviation	Minimum Value	Maximum Value
per capita energy consumption	234.80	222.57	10.38	2615.00
per capita non - commodity energy consumption	438.15	357.30	1.14	2849.71
per capita conventional energy consumption	601.54	422.59	10.38	3605.00
per capita new energy consumption	1.15	3.03	0.09	43.33
per capita renewable energy consumption	406.87	362.16	0.09	2849.71
per capita non - renewable energy consumption	234.23	222.52	10.38	2615.00
per capita clean energy consumption	171.02	133.49	10.00	1000.00
per capita pollution energy consumption	493.10	393.86	11.83	3585.00

Regression Results and Discussion

Regression Results

1. The impact of the labor force transfer on farmer's commodity and non-commodity energy consumption.

Model 1 mainly analyzes the influence of the number of transferred labor force, per capita labor transfer income and backflow labor force occupation on the per capita commodity energy consumption of farmers. Model 1′ analyzes the influence of labor transfer variables on per capita energy consumption of commodities on the basis of adding control variables of family characteristics, energy availability and consumption willingness.

Model 2 and model 2′ are based on model 1 and model 1′, and analyzed the influence of labor transfer on the per capita non-commodity energy consumption under the condition that the independent variables and control variables are unchanged.

Table4. *Analysis on the regression results of labor force transfer to the commodity and non-commodity energy consumption of farmer households (N = 668)*

Variable	Per capita commodity energy consumption		per capita non-commodity energy consumption	
	Model1	Model1′	Model2	Model2′
Constant term	177.18***	51.39	604.64***	359.32
Labor transfer				
number of transferred labor force	20.69	71.93*	-34.84	-15.98
per capita labor transfer income	0.01	-0.01	-0.01	-0.01
backflow labor force occupation (industry)				
service industry	127.01	288.17**	-323.92**	-158.23
agriculture	-58.45	-56.39	-59.77	66.03
Basic family characteristics				
per capita agricultural net income		-0.01		-0.01
family size		-27.18		-35.05
the age of household head		-1.33		-1.38
the education level of the household		0.16		28.48^{+}
Energy availability				
per capita arable land		93.31**		69.69^{+}
distance to the highway		0.64***		-0.29
Consumption preferences(Biomass)				
commodity energy		141.59**		-169.25*
new energy		83.89		-45.01
Pseudo R^2	0.0846	0.6419	0.1148	0.2943

Notes：*** p<0.001; ** p<0.01; * p<0.05; +p<0.1。

2. The impact of the labor force transfer on farmers' conventional energy and new energy consumption.

Table5. *The results of the regression analysis of the labor force transfer to farmer's conventional energy and new energy consumption（N=668）*

Variable	Per capita conventional energy consumption		Per capita new energy consumption	
	Model3	Model3′	Model4	Model4′
Constant term	781.30***	411.47	0.51	-0.76^{+}
Labor transfer				
number of transferred labor force	-14.31	56.01	0.16	-0.05
per capita labor transfer income	-0.01	-0.01	0.01	0.01*
backflow labor force occupation (industry)				
service industry	-195.29	130.34	-1.61	-0.40^{+}
agriculture	-117.17^{+}	9.75	-1.06	-0.10
Basic family characteristics				
per capita agricultural net income		-0.02		0.01
family size		-62.32		0.09^{+}
the age of household head		-2.71		-0.01
the education level of the household		28.57		-0.06*
Energy availability				
per capita arable land		162.91**		0.09
distance to the highway		0.35		-0.01^{+}
Consumption preferences(Biomass)				
commodity energy		-27.93		0.27*
new energy		38.45		0.43**
Pseudo R^2	0.0457	0.3704	0.0353	0.4468

Notes：*** p<0.001; ** p<0.01; * p<0.05; +p<0.1。

Model 3 mainly analyzes the impact of labor force transfer, the per capita labor force transfer income and the backflow labor force occupation on farmer's per capita conventional energy

consumption. Model 3' analyzes the influence of labor transfer related variables on the per capita conventional energy consumption of farmers on the basis of adding control variables of family characteristics, energy availability and consumption willingness.

Model 4 and model 4' are based on model 3 and model 3', and the influence of labor transfer on farmers' per capita new energy consumption is analyzed under the condition that the independent variables and control variables are unchanged.

3. The impact of the labor force transfer on farmers' renewable energy and non - renewable energy consumption.

Model 5 mainly analyzes the impact of labor force transfer, per capita labor transfer income and backflow labor force occupation on per capita renewable energy consumption of farmers. Model 5' analyzes the impact of labor transfer related variables on the per capita renewable energy consumption of farmers on the basis of adding control variables such as family characteristics, energy availability and consumption willingness.

Model 6 and model 6' are based on model 5 and model 5', and the influence of labor transfer on the per capita non-renewable energy consumption of farmers is analyzed under the condition that the independent variables and control variables are unchanged.

Table6. *Analysis of the results of the labor force transfer to the household renewable energy and non-renewable energy consumption (N = 668)*

Variable	Per capita renewable energy consumption		Per capita non-renewable energy consumption	
	Model5	Model5′	Model6	Model6′
Constant term	605.15***	358.56	176.66***	52.15
Labor transfer				
number of transferred labor force	-34.68	-16.04	20.53	71.98*
per capita labor transfer income	-0.01	-0.01	0.01	-0.01
backflow labor force occupation (industry)				
service industry	-325.53**	-158.63	128.63	288.57**
agriculture	-60.83	65.93	-57.40	-56.28
Basic family characteristics				
per capita agricultural net income		-0.02		-0.01
family size		-62.32		-27.27
the age of household head		-2.71		-1.33
the education level of the household		28.57		0.09
Energy availability				
per capita arable land		162.91**		93.22**
distance to the highway		0.35		0.64***
Consumption preferences(Biomass)				
commodity energy		-27.93		141.32**
new energy		38.45		83.46
Pseudo R^2	0.1152	0.2947	0.0834	0.6422

Notes：*** p<0.001; ** p<0.01; * p<0.05; +p<0.1。

4. The impact of labor transfer on farmers' pollution energy and clean energy consumption.

Model 7 mainly analyzes the impact of the number of labor transfer, the per capita labor transfer income and the backflow labor force on the per capita pollution energy consumption of farmers. Model 7′ analyzes the influence of labor transfer variables on the per capita pollution energy consumption of farmers on the basis of adding control variables such as family characteristics, energy availability and consumption willingness.

Model 8 and model 8' are based on model 7 and model 7', and the influence of labor transfer on the per capita clean energy consumption of farmers is analyzed under the condition that the independent variables and control variables are unchanged.

Table7. *The results of the regression analysis of the labor force transfer to farmer households' pollution energy and clean energy consumption(N = 668)*

Variable	Per capita pollution energy consumption		Per capita clean energy consumption	
	Model7	Model7′	Model8	Model8′
Constant term	625.53***	363.45	156.28***	47.26
Labor transfer				
number of transferred labor force	-8.06	46.68	-6.08	9.27
per capita labor transfer income	-0.01	-0.01^{+}	0.01**	0.01
backflow labor force occupation (industry)				
service industry	-198.48	70.96	1.57	58.98
agriculture	-93.45	38.85	-24.77	-29.20
Basic family characteristics				
per capita agricultural net income		-0.01		-0.01^{+}
family size		-58.48		-3.75
the age of household head		-2.36		-0.35
the education level of the household		24.83		3.81
Energy availability				
per capita arable land		120.12*		42.88**
distance to the highway		0.27		0.08
Consumption preferences(Biomass)				
commodity energy		-61.62		33.96
new energy		-25.20		64.08^{+}
Pseudo R^2	0.0606	0.2614	0.0745	0.4232

Notes: **** p<0.001; ** p<0.01; * p<0.05; +p<0.1。*

Discuss

From the analysis of Table 4, we can see that there is a significant positive correlation between labor force transfer and per capita commodity energy consumption. Compared to the industry, the backflow labor force engaged in service industry has a significant positive correlation with per capita commodity energy consumption, and has a significant negative correlation with the per capita non-commodity energy consumption. The education level of the householder has a significant negative correlation with the per capita non-commodity energy consumption. There is a significant positive correlation between per capita cultivated land area and per capita commodity energy and per capita non-commodity energy consumption. The distance between the farmer and the highway is positively correlated with per capita energy consumption. Compared to biomass energy, the farmers' preference for the use of commodities has a significant positive correlation with the per capita commodity energy consumption, and has a significant negative correlation with the per capita non-commodity energy consumption.

From the analysis of Table 5, we can see that there is a significant positive correlation between per capita labor force transfer income and per capita new energy consumption. The number of resident population has a significant positive correlation with the per capita new energy consumption of farmers. The education level of the householder has a significant positive correlation with the per capita new energy consumption. The per capita cultivated land area has a significant positive correlation with per capita conventional energy consumption of farmers. Compared to biomass energy, there is a significant positive correlation between the use of commodities and new energy and the per capita new energy consumption of farmers.

From the analysis of Table 6, we can see that there is a significant positive correlation between the number of labor force transfer and per capita non-renewable energy consumption of farmers. Compared to the industry, the backflow labor force engaged in the service industry has a significant negative correlation with per capita renewable energy consumption of farmers, and has a significant positive correlation with per capita non-renewable energy consumption of farmers. The education level of the householder has a significant positive correlation with the consumption of per capita renewable energy. The per capita cultivated land area has a significant positive correlation with the per capita renewable

energy and non-renewable energy consumption of farmers. The distance between the farmers and the highway is positively correlated with the per capita consumption of non-renewable energy. Compared to biomass energy, the farmers' preference for the use of commodities has a significant negative correlation with the per capita renewable energy consumption of farmers, and has a significant positive correlation with the per capita non-renewable energy consumption of farmers.

From the analysis of Table 7, it can be seen that per capita labor force transfer income has a significant negative correlation with per capita pollution energy consumption of farmers, and has a significant positive correlation with the per capita clean energy consumption of farmers. The per capita agricultural net income has a significant negative correlation with household consumption of clean energy. There is a significant positive correlation between per capita cultivated land area and per capita pollution energy and per capita clean energy consumption of farmers. Compared to biomass energy, the farmers' propensity to use new energy has a significant positive correlation with the per capita clean energy consumption of farmers.

CONCLUSION

This paper gives a few conclusions about the research and analysis of energy consumption in different combinations：

- The transfer of labor force has a significant impact on the energy consumption of different combinations of farmers. The more the quantity of labor transferred in the family, the less the resident population of the former rural households, and most of the remaining are old, women and children, all of them are vulnerable groups. Family labor ability is greatly weakened, so the original members of the family will choose to use energy that is more convenient and not spend too much manpower.In addition, farmers will gradually increase the consumption of commodity energy, which is easy to obtain and simple to use, at the same time reduce the use of non-renewable energy that complex to use, large in human cost and low efficiency in the use. Farmers' household population increases, and because of the increase in labor force, families will choose to use non-commodity and renewable energy that is more complex to use and relatively low in cost, which saves money and makes full use of the family's labor resources. Through the increase of labor transfer income in the family, the economic level of the family improves, the living standards also rise, and the life goal that people pursuits also changes correspondingly. Pollution energy can cause serious pollution problems. Pollution energy not only pollutes the environment but also releases the ingredients that can seriously harm people's body and affect their health. With the improvement of living standards and the enhancement of people's safety, environmental protection and health consciousness, people will gradually reduce the use of pollution energy sources and increase the use of clean energy. In terms of the occupation after the return of the labor force, compared to industry, the backflow labor force engaged in service industry has a significant positive correlation with per capita commodity energy consumption and per capita non-renewable energy consumption, and has a significant negative correlation with the per capita non-commodity energy consumption and per capita renewable energy consumption.
- The variables related to family characteristics include per capita agricultural net income, family size, household age and household education level all have a certain impact on the energy consumption of rural households. More household agricultural income leads to the improvement of family living conditions, and with the increase in agricultural income, farmers' demands for life are also improving. For this reason, families tend to use clean energy as it is clean, convenient and hygienic. The new energy in this paper is solar energy. Solar energy is a one-time input cost energy, which can be used sustainably after the first investment without any subsequent economic input. Therefore, after the first purchase, the amount of solar energy consumption depends on the number of people using it. The more the resident population, the more new energy sources will be used. With the increase of the education years, householder's thought is more open and the outlook on life and values is becoming more and more advanced. The more the education years, the easier it is for householders to accept new things quickly, the more able to use advanced energy. Therefore, the longer the years of education, the more non-commercial energy and new

energy will be used by their families.

- The availability of energy has a certain impact on the energy consumption of rural households. There is a significant positive correlation between per capita cultivated land area and per capita commodity energy, per capita non-commodity energy, per capita conventional energy, per capita renewable energy, per capita non-renewable energy, per capita pollution energy and per capita clean energy consumption. The larger the per capita arable land, the larger the agricultural scale, and the more energy is produced by the agricultural production process. These energy is easy to obtain and low in cost, therefore, farmers will increase the consumption of these energy sources, which will increase the consumption of non-commodity, conventional, renewable and polluting energy sources. The shorter the distance between the household and highway, the closer the household to the commodity energy market, which makes the lower cost of obtaining commodity energy. Therefore, people will increase the consumption of the commodity energy and non-renewable energy. The easier the energy acquisition means the reduction in energy acquisition costs, energy consumption costs and energy prices, and the price reduction will naturally lead to an increase in energy consumption.
- Farmers' willingness to consume affects their energy consumption. Compared to biomass energy, the farmers' preference for the use of commodity energy can have a significant positive correlation with per capita commodity energy, per capita non-renewable energy and per capita new energy consumption, and have a significant negative correlation with per capita non-commodity energy, per capita renewable energy consumption. The farmers' preference for the use of new energy has a significant positive correlation with per capita new energy and per capita clean energy.

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