Analysis on Spatial Pattern of Cultivated Land Use Intensity in Hubei Province Based on Energy Value Analysis

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Abstract: Under the background of the sharp reduction of cultivated land resources and limited reserve resources of cultivated land, it is an inevitable trend to tap the potential and improve the intensive use of cultivated land. Taking Hubei Province as an example, using the method of energy value analysis, the intensive degree of cultivated land use is measured from the perspective of input indicators, and the labor intensive degree, mechanized intensive degree, fertilizer intensification degree, pesticide intensive degree and film intensive degree of cultivated land in 2011 are analyzed. Then, based on these five input energy values, the spatial pattern of cultivated land use intensification in the study area is analyzed. The results show that the agricultural machinery intensive degree accounts for more than 99% of the intensive use of cultivated land, and science and technology is an important breakthrough point for China to achieve agricultural modernization; the research area presents a spatial pattern of “intermediate high and low wings”. The study on the intensive use of regional cultivated land can better manage cultivated land resources, ensure food security, increase farmers' income and coordinate the sustainable development of regional economy.

1. Introduction

With the rapid economic growth, the continuous development of the population, the deterioration of the environment and the continuous depletion of resources have become problems that human beings cannot avoid. Under this reality, the area of cultivated land has dropped sharply, and food security is threatened. The change in cultivated land use has once become a hot issue of concern to the government and scholars. The cultivated land resources are also non-renewable resources to a certain extent. The trend of reducing the total cultivated land area is difficult to reverse for a long time in the future [1]. Increasing the intensive use of cultivated land has become a guarantee for food security, increasing farmers' income, and coordinating regional social economy. An important choice for sustainable development. Taking Hubei Province as an example, this paper uses energy value analysis method to study the spatial pattern of cultivated land use intensification in Hubei Province, and analyzes the obvious regionality of cultivated land use. It also points out that the study of regional cultivated land use intensification has important practical significance.

2. Overview of the study area

As a major agricultural province, Hubei Province is dominated by ploughing operations, and grain production is at the forefront. It is one of China's major grain producing areas. Hubei Province is located in central China, in the middle reaches of the Yangtze River, north of Dongting Lake, between 29°05′ and 33°20′ north latitude, and 108°21′ to 116°07′ east longitude, with an area of 185,900 square kilometers. Hubei Province is the economic center and transportation hub of the country. There are 1 sub-provincial city, 12 prefecture-level cities, 1 autonomous prefecture, 3 provinces directly under the city, and 1 province directly under the forest area (Shen Nongjia). The terrain of the study area is roughly surrounded by mountains on the east, west and north, with a low level in the middle and a slightly incomplete basin open to the south. Among the total area of the province, mountains account for 55.5% of the province's total area, hills and hills account for 24.5%, and plain lakes account for 20%. Except for the mountains, most of the province is a subtropical

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monsoon humid climate with abundant light energy, abundant heat, long frost-free period, abundant precipitation, and rain and heat in the same season. Agricultural production conditions are relatively superior. By the end of 2011, the area of cultivated land in Hubei Province was 3,361.86 thousand hectares, accounting for 22.19% of the total land area, mainly distributed in Jianghan Plain, Ebei Gangdi and Edong River Plain. The per capita cultivated land area was 0.82 mu, which was lower than the national per capita cultivated land area. At present, Hubei Province generally has the problem of farmland quality deviation, extensive use of cultivated land, and insufficient reserve resources of cultivated land. Studying the intensive use of cultivated land in Hubei Province will effectively improve land use efficiency and better allocate and utilize resources.

3. Data sources and research methods

3.1 Data source

The data involved in this paper are mainly the input measurement data of the intensive level of cultivated land use in 2011, specifically, the area of cultivated land at the end of the year, the agricultural workers, the total power of agricultural machinery, the amount of chemical fertilizer used (purified amount), the amount of pesticide used and the use of plastic film. the amount. All the data in this paper are from the “Hubei Rural Statistical Yearbook 2012” and the statistical yearbooks of cities in Hubei Province.

3.2 Research methods

3.2.1 Emergy theory and emergy analysis method

Emergy theory and analysis method is the research theory and method of eco-economic system founded by American ecologist HTOdum in the 1980s. The new scientific concept and metrics of energy value and its conversion unit can The value conversion rate can convert various forms of energy into a unified unit—solar Joule (sej), which can be used to comprehensively analyze and evaluate the system's energy logistics, currency flow, population flow, and information flow. The energy value indicators that reflect the structural and functional characteristics of the system and the ecological and economic benefits, and evaluate the sustainable development performance and decision-making of the system.

3.2.2 Cultivated land intensification assessment based on energy value analysis

The intensive degree of cultivated land use refers to the quantity of non-land element inputs per unit area of unit time [2]. Land intensive or extensive use is essentially a substitute between economic factors such as capital and labor and land area. Therefore, input measurement is the basic measure of intensification [3]. The energy conversion rate of labor, agricultural machinery power, fertilizer, pesticide and mulch film in this paper comes from the research results of Odum and Lan Shengfang [4], and the conversion data involved refer to "Agricultural Ecology" [5]. German agricultural economist Brinkmann uses the input to define the intensive measure method of intensiveness. The calculation formula is as follows:

$$I = (A + K + Z) / F \tag{1}$$

Where: I is the intensive degree, A is the labor wage, K is the capital consumption amount, Z is the operating capital interest, and F is the operating land area.

Combined with the actual situation of this paper, the intensive degree of cultivated land use can be defined as the total energy value of non-land elements invested in a unit area of cultivated land within a certain period of time. This non-land element starts from labor, capital and technology. which is:

$$I = (L + C + T) / S \tag{2}$$

Where: I is the intensive degree of cultivated land use, sej/hm2; C is the energy value of the material capital invested in the cultivated land, sej; L is the labor energy value input into the

cultivated land, sej; T is the technology invested in the cultivated land Energy value, sej; S is the area of cultivated land, hm2

This study will analyze the spatial pattern of the intensive use of cultivated land in Hubei Province based on the energy values of the above five kinds of physical inputs. The energy values of the main indicators are calculated as follows:

1) Labor energy value

$$L_E = T_L \cdot C_L \cdot N_L \tag{3}$$

Where: LE is the energy value of labor input; TL is the labor energy conversion rate, 3.80×105sej/J; CL is the energy conversion coefficient of labor, 3.50×109J/person; NL is agricultural practitioner (person).

2) Fertilizer energy value

$$F_E = A\%_N \cdot T_N + A\%_P \cdot T_P + A\%_K \cdot T_K + A\%_M \cdot T_M \tag{4}$$

Where: FE is the energy value of chemical fertilizer input; AN, AP, AK, and AM are nitrogen fertilizer, phosphate fertilizer, potassium fertilizer and compound fertilizer use amount (purified amount); TN, TP, TK, TM respectively nitrogen fertilizer, phosphate fertilizer, potassium fertilizer and The compound fertilizer energy conversion rate is 4.62 × 109 sej / g, 1.78 × 10 10 sej / g, 2.96 × 109 sej / g and 2.80 × 109 sej / g.

3) Pesticide energy value

$$P_E = T_P \cdot N_P \tag{5}$$

Where: PE is the total energy value of the input pesticide; TP is the conversion rate of the pesticide energy value, 1.62 × 109 sej / g; NP is the amount of pesticide used.

4) Film energy value

$$D_E = T_D \cdot N_D \tag{6}$$

Where: DE is the total energy value of the input film; TD is the conversion rate of the film energy value, 3.80×108 sej/g; ND is the amount of film used.

5) Agricultural machinery Energy value

$$M_E = T_M \cdot C_M \cdot P_M \cdot z \tag{7}$$

Where: ME is the energy input value of mechanical input; TM is the energy conversion rate of agricultural machinery, 7.50×107sej/J; CM is the energy conversion coefficient of agricultural machinery power, 2.10×108J/kg; PM is the total power of farmland agricultural machinery (KW));z is the value of the kilowatts of various machines folded into kilograms and then multiplied by the depreciation coefficient of 0.1, the power machinery (M1) is 104.72kg/KW, the irrigation and drainage machinery (M2) is 4.96 kg/KW, and the large farm tools (M3)) is 393.04 kg/KW. In this study

$$z = 0.1 \times \left[\frac{M_a}{M_a + M_b + M_c} \times M_1 + \frac{M_b}{M_a + M_b + M_c} \times M_2 + \frac{M_c}{M_a + M_b + M_c} \times M_3 \right] \tag{8}$$

In the formula: Ma is the gasoline engine power, KW; Mb is the motor power, KW; Mc is the diesel engine power, KW.

4. Results and analysis

The energy value analysis method is used to calculate the intensification degree of five input factors and the intensive use of cultivated land in various cities in Hubei Province. In the five kinds of input intensification degree, there is no significant gap in the labor intensification degree of each city, and the labor in Ezhou City Intensive degree is the highest; except for Ezhou, there is no

obvious gap between other prefecture-level cities, pesticide intensive degree and film intensive degree are low in all levels; agricultural machinery intensiveness accounts for the largest proportion of cultivated land use intensification. The lowest in Enshi Autonomous Prefecture, the highest in Jingmen City. On the whole, labor intensiveness and capital intensiveness in the study area only accounted for a small proportion, while agricultural machinery intensiveness accounted for more than 99% of the intensive use of cultivated land, which can be seen in current agricultural development, technology, etc. Provincial labor input has played an important role in it. Science and technology development is an important breakthrough point and inevitable trend of agricultural modernization in the future.

Using the hierarchical clustering function in SAS software, the intensive use degree of cultivated land is divided into five types: extensive utilization, low intensive use, moderate intensive use, highly intensive use, and fine utilization. The spatial pattern of cultivated land intensive use in the study area is analyzed. , using ArcGIS to demonstrate the results. From the results, the intensive use of cultivated land in Hubei Province presents a spatial pattern of “intermediate high and low wings” in space. Among them, Enshi Autonomous Prefecture, Huangshi City, Huanggang City, Xiaogan City and Shiyan City are widely used; Ezhou City, Xianning City and Shennongjia Forest Area are used in low-level intensive use; Jingzhou City, Yichang City and Wuhan are moderately intensively utilized. City; Qiangjiang City and Xiantao City are highly intensively utilized; Fuyang City, Tianmen City, Suizhou City and Jingmen City are used in fine use.5

5. Through the above analysis, the following conclusions can be drawn:

(1) Among the five input factors of cultivated land use in Hubei Province, labor intensiveness and capital intensiveness only account for a small proportion, and agricultural machinery intensiveness accounts for more than 99% of cultivated land use intensiveness. Investment plays an important role in current agricultural development. In addition to reasonable capital and technology investment, providing farmers with adequate agricultural knowledge and skills training services, supporting a variety of benefits policies to promote the continued growth of farmers' income is also an important part. In recent years, due to the relatively low efficiency of engaging in agriculture, the Chinese government has actively introduced a series of policies to subsidize farmers to increase farmers' enthusiasm for planting land, deepen farmers' awareness of protecting cultivated land, improve land use efficiency, and better allocate and utilize. Resources. In this process, the intensive use of cultivated land has been greatly improved, but correspondingly it has brought many ecological and environmental problems, especially focusing on capital investment (including fertilizers, pesticides, herbicides, etc.) and neglecting the bearing of the land itself. This will not only endanger our living environment, but also threaten our lives. We must remain vigilant and vigorously improve the scientific and technological level of agricultural development to prevent the negative externalities brought about by the improvement of the intensive use of cultivated land and maintain the coordinated and sustainable development of nature, society and economy.

(2) The intensive use of cultivated land in Hubei Province presents a pattern of “intermediate high and low wings” in space, forming this spatial pattern. On the one hand, due to its topographical conditions, the topography of Hubei Province is generally high in the northwest and low in the southeast. The trend is roughly the east, west and north, surrounded by mountains, the middle is low, and the south is slightly open to the incomplete basin. It explains that the areas of extensive utilization and low intensive use are mainly distributed in the two wings of hills and mountains. The areas of intensive use, highly intensive use, and fine utilization are mainly distributed in the central region, that is, the spatial pattern of “middle high and low wings”; on the other hand, it is also affected by the distribution of 46 major grain producing areas and cultivated land areas in Hubei Province. The infrastructure of the main grain producing areas is more complete, the technology is more mature, the incentive effect of the policy is more obvious, and the corresponding intensive use of cultivated land is higher than that of other areas; in addition, the level of intensive use of cultivated land and local The level of economic development is closely related. In areas with high levels of economic development, capital and technology inputs are relatively large; in general, the

intensity of cultivated land use is high. It is the result of natural, economic, social.

The energy value model in this paper uses the solar energy conversion rate calculated by HT Odum. The energy conversion rate of human economic products will vary due to differences in production levels and benefits, which may bring specific energy value analysis practices. Deviation, but has little effect on the results. This paper only analyzes the spatial pattern of cultivated land use intensification in Hubei Province. The analysis of its temporal and spatial pattern characteristics and its future development trend will be further research directions.

References

[1] Chen Yuqi, Li Xiubin. Structural Characteristics of Intensive Use of Cultivated Land Use in China since 1980[J]. Journal of Geographical Sciences, 2009, 64(4): 469 - 478.

[2] Xie Hualin, Zou Jinlang, Peng Xiaolin. Analysis of Spatial and Temporal Differences of Cultivated Land Use Intensity in Poyang Lake Ecological Economic Zone Based on Emergy[J]. Acta Geographica Sinica, 2012, 67(7): 889-902.

[3] Yao Chengsheng, Huang Lin, Lu Wei, et al. Analysis of temporal and spatial variation of intensive use of cultivated land in China based on emergy theory [J]. Transactions of the Chinese Society of Agricultural Engineering, 2014, 30(8): 1-12.

[4] Zeng Jie, Yao Xiaowei. Temporal and spatial differentiation characteristics of intensive use of cultivated land in Wuhan urban agglomeration [J]. Transactions of the Chinese Society of Agricultural Engineering, 2013, 29(19): 215-223.

[5] Zhao Jing, Yang Gangqiao. Analysis of the Intensification of Cultivated Land Use and Its Driving Factors——A Case Study of Hubei Province [J]. RESOURCES AND ENVIRONMENT IN THE YANGTZE BASIN, 2012, 21(1): 30-35.