Evaluation on Development Level of Rural Circular Economy in Hebei Province, China

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Abstract According to availability of rural data, and the actual situation of economic development in different areas, 1 first grade index, 4 second grade indices and 20 third grade indices are selected to establish the measurement index system of circular economic development level in rural areas. According to the relevant data, standardized processing of data is conducted. Evaluation on circular economic level in Hebei Province by Factor Analysis indicates that comprehensive score of Shijiazhuang, Qinghuangdao and Tangshan Cities is the highest, that of Xingtai, Handan, Langfang, Baoding, Cangzhou Cities is at a medium level, and that of Hengshui, Chengde and Zhangjiakou is the lowest. Meanwhile, cluster analysis on data after standardization shows that Handan, Baoding, Qinhuangdao, Xingtai, Langfang, Cangzhou and Hengshui belong to the first class; Shijiazhuang and Tangshan belong to the second class; and Zhangjiakou and Chengde belong to the third class. Thus, we can conclude that rural circular economic status in Hebei Province is determined by the proximity of geography and landscape feature. Finally, countermeasures are put forward to realize the harmonious development of rural economy, society and environment and to promote the process of new socialist countryside construction, such as increasing governments' input in construction of rural circular economy, promoting the development of rural circular economy from the aspect of industrial policy, promoting the construction of rural circular economic market in adjacent areas, and implementing mandatory public participation.

Key words Rural circular economy; Factor analysis; Cluster analysis; China

For a long time, agricultural economy in China follows a road of traditional and extensive growth. Pressure on population, resource and environment is increasing. When speeding up the construction of new countryside, how to keep the mutual coordination among environment, economy and resources to realize the sustainable development of rural economy has become the hot spot for experts and scholars. During the agricultural resource input, production, products consumption and wastes of agricultural circular economy, traditional linear growth economy depending on agriculture and resource consumption has changed into an economy depending on ecological agricultural resource, which offers a new method of economic development mode with environment friendly to use natural resources and environmental capacity and to realize the ecological change of economic activity[1]. Therefore, according to the relevant data, agricultural circular economic level of Hebei Province is evaluated and analyzed by Factor Analysis Method in order to provide guidance for policy making of governments.

1 Index selection, data source and research method

1.1 Data selection According to the availability of rural data, the actual situation of economic development in different areas, and the relationships between the rural economic and social development and the ecological environment, a total of four subsystems are selected to establish the evaluation index system of circular economy in rural areas, including the rural production circular economic evaluation index, rural life circular economic evaluation index, rural circular economic and social support evaluation index, rural circular economic and environmental support evaluation index.

1.2 Data source Research data are mainly from the Second Agricultural Investigation Bulletin of Hebei Province and the 2007 *Hebei Agricultural Statistical Yearbook* (Table 2). Among the indices, waste water discharge per ten thousand yuan output value, waste gas discharge per ten thousand yuan output value, and waste residue per ten thousand yuan output value can not obtain their initial data at present due to the lack of rural waste water, waste gas and waste residue emissions in different areas and Hebei Province. Proportions of households having biogas and with latrine improvement are replaced by those in similar villages according to the second agricultural investigation of Hebei Province.

1.3 Research method Factor analysis method is used to evaluate the rural circular economic development status in 11 areas of Hebei Province. Factor analysis method is an optimal comprehensive evaluation method based on eigenvector which does not need objective determination of weight and the evaluation result is close to the actual situation. Development status of rural circular economy is calculated mainly according to the annual data in different regions of Hebei Province. After standardized processing of data, index weight is determined. Then, comprehensive score of regional development status is obtained by factor analysis method. After evaluating the 11 regions in Hebei Province by factor analysis method, cluster analysis on data after standardization is conducted in these 11 re-

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gions in order to find out the regional similarity.

Table 1 Evaluating index system of the development level of rural circular economy in Hebei Province, China

First grade index	Second grade index	Third grade index
Index of the development level of rural circular economy A	Rural production circular economic evaluation index B_1	Fertilizer use intensity (negative index) C_1
		Pesticide use intensity (negative index) C_2
		Rural power consumption efficiency C_3
		Multiple cropping index C_4
		Proportion of water-saving irrigation area C_5
		Waste water discharge per ten thousand yuan output value C_6
		Waste gas discharge per ten thousand yuan output value C_7
		Waste residue per ten thousand yuan output value C_8
	Rural life circular economic evaluation index B_2	Proportion of towns with centralized processing of domestic sewage C_9
		Proportion of villages with centralized processing of garbage C_{10}
		Proportion of households having biogas digester C_{11}
		Proportion of households with latrine improvement C_{12}
		Proportion of villages with harmless treatment facility of livestock manure in culture area C_{13}
	Rural circular economic and social support evaluation index B_3	Proportion of rural financial expenditure C_{14}
		Proportion of agricultural technicians in rural per ten thousand population C_{15}
		Ratio of agricultural industrialization to gross agricultural output value C_{16}
		Proportion of rural employees with junior high school education C_{17}
	Rural circular economic and environmental support evaluation index B_4	Forest coverage C_{18}
		Proportion of control area of water and soil loss in total loss area C_{19}
		Proportion of forest and grass area in cultivated land C_{20}

Table 2 Data of development level of rural circular economy in Hebei Province, China

Area	C_1	C_2	C_3	C_4	C_5	C_9	C_{10}	C_{11}	C_{12}
Shijiazhuang City	580.82	13.08	56.93	1.72	0.31	22.5	34.1	73.3	24.2
Tangshan City	710.13	6.90	38.66	1.41	0.34	17.2	32.2	48.6	24.6
Qinhuangdao City	854.65	23.83	73.60	1.17	0.27	22.5	18.8	52.9	13.8
Handan City	620.37	7.22	66.62	1.61	0.23	16.5	19.0	77.8	11.9
Xingtai City	654.89	10.34	79.86	1.53	0.19	17.9	16.3	40.3	11.4
Baoding City	671.39	9.18	83.65	1.49	0.27	15.3	19.8	42.0	12.1
Zhangjiakou City	1 253.01	4.68	94.58	0.80	0.20	13.5	12.8	12.1	12.9
Chengde City	1 100.08	3.47	54.03	0.91	0.32	8.0	8.5	68.8	15.4
Cangzhou City	673.25	11.68	61.65	1.49	0.33	20.5	8.2	21.5	8.9
Langfang City	734.47	5.68	54.67	1.36	0.33	12.7	22.6	16.1	14.6
Hengshui City	690.70	9.99	67.72	1.45	0.35	9.7	6.3	21.7	10.7

Area	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}
Shijiazhuang City	5.3	0.04	8.98	1.03	48.21	0.23	70.24	0.84
Tangshan City	3.5	0.06	11.73	0.55	50.13	0.25	98.24	0.40
Qinhuangdao City	1.6	0.04	10.24	1.06	49.77	0.39	98.49	0.89
Handan City	2.6	0.05	5.31	0.61	45.37	0.20	87.14	0.92
Xingtai City	1.8	0.04	3.99	1.20	50.97	0.17	98.08	0.63
Baoding City	1.8	0.04	5.05	0.47	47.53	0.16	80.55	0.96
Zhangjiakou City	1.2	0.04	14.52	0.57	42.71	0.28	86.02	2.67
Chengde City	0.8	0.05	20.12	0.64	46.40	0.49	85.95	5.03
Cangzhou City	1.5	0.05	5.75	0.68	51.15	0.05	82.30	0.66
Langfang City	2.8	0.04	7.23	1.13	49.84	0.16	82.39	0.26
Hengshui City	0.9	0.05	5.55	0.56	52.94	0.09	36.78	0.67

2 Analysis of regional circular economy in rural Hebei Province

2.1 Standardization of data In order to achieve comparability of index data, standardized processing on data is conducted. Process equation is

$$x_{ij} = \frac{x'_{ij} - \bar{x}_j}{\sqrt{S_j^2}},$$

where $\bar{x}_j = \frac{1}{n}\sum_{i=1}^{n} x'_{ij}$, $S_j^2 = \frac{1}{n-1}\sum (x'_{ij} - \bar{x}_j)^2$.

Table 3 indicates the standardized index value of rural cir-

cular economic development level in Hebei Province after the standardization of data in Table 1.

Table 3 Standardized index value of rural circular economic development level in Hebei Province, China

Area	C_1	C_2	C_3	C_4	C_5	C_9	C_{10}	C_{11}	C_{12}
Shijiazhuang City	1.28	−0.82	−0.61	1.27	0.43	1.35	1.75	1.28	1.86
Tangshan City	0.18	0.16	−1.76	0.18	0.95	0.24	1.54	0.23	1.93
Qinhuangdao City	−0.65	−1.31	0.45	−0.66	−0.27	1.35	0.08	0.41	−0.15
Handan City	0.89	0.07	0.00	0.88	−0.97	0.10	0.10	1.47	−0.52
Xingtai City	0.59	−0.53	0.84	0.60	−1.66	0.39	−0.19	−0.12	−0.62
Baoding City	0.46	−0.35	1.08	0.46	−0.27	−0.15	0.19	−0.05	−0.48
Zhangjiakou City	−1.95	1.14	1.77	−1.95	−1.49	−0.53	−0.57	−1.32	−0.33
Chengde City	−1.57	2.20	−0.79	−1.57	0.60	−1.67	−1.04	1.09	0.16
Cangzhou City	0.45	−0.69	−0.31	0.46	0.78	0.93	−1.08	−0.92	−1.10
Langfang City	0.02	0.60	−0.75	0.01	0.78	−0.69	0.50	−1.15	0.00
Hengshui City	0.32	−0.48	0.07	0.32	1.13	−1.32	−1.28	−0.91	−0.75

Area	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}
Shijiazhuang City	2.36	−0.79	0.01	0.95	−0.14	0.04	−0.70	−0.30
Tangshan City	1.01	2.12	0.56	−0.82	0.50	0.20	0.91	−0.62
Qinhuangdao City	−0.42	−0.79	0.26	1.06	0.38	1.30	0.92	−0.27
Handan City	0.33	0.66	−0.74	−0.60	−1.11	−0.19	0.27	−0.25
Xingtai City	−0.27	−0.79	−1.01	1.57	0.79	−0.43	0.90	−0.45
Baoding City	−0.27	−0.79	−0.79	−1.11	−0.37	−0.51	−0.11	−0.22
Zhangjiakou City	−0.73	−0.79	1.13	−0.75	−2.00	0.44	0.21	1.00
Chengde City	−1.03	0.66	2.27	−0.49	−0.76	2.09	0.20	2.69
Cangzhou City	−0.50	0.66	−0.65	−0.34	0.85	−1.37	0.00	−0.43
Langfang City	0.48	−0.79	−0.35	1.31	0.41	−0.51	0.00	−0.72
Hengshui City	−0.95	0.66	−0.69	−0.78	1.45	−1.06	−2.62	−0.43

2.2 Calculation of comprehensive score According to the SPSS16.0 Statistical Analysis Software and factor analysis, fertilizer application strength (reciprocal value), pesticide application strength (reciprocal value), rural power consumption efficiency, multiple cropping index, proportion of water-saving irrigation area in cultivated land, and proportion of towns with centralized processing of domestic sewage have relatively high loads of the first factor, with the weight of 35.54%, indicating that they have relatively high correlation with the first factor. Thus, the first factor is mainly the agricultural production circular factor. Proportion of households having biogas digester, proportion of households with latrine improvement, proportion of villages with harmless treatment facility of livestock manure in culture area, proportion of rural financial expenditure, and proportion of agricultural technicians in rural per ten thousand population have relatively high loads of the second factor, with the weight of 22.19%. Thus, the second factor is mainly the rural life circular and financial and technical support factor. Ratio of total agricultural industrialization to total agricultural output has relatively high load at the third factor, with the weight of 17.01%. Thus, it is mainly the driving factor of agricultural industry. Proportion of rural employees with junior high school education has relatively high load at the fourth factor, with the weight of 7.46%, which mainly focuses on the farmer's education quality factor. Forest coverage, proportion of control area of water and soil loss in total loss area, and proportion of forest and grass area in cultivated land have relatively high load at the fifth factor with the weight of 5.89%, which are mainly the environmental protection factors. Cumulative contribution rate of the total five factors is 88.09%. Table 4 reports the comprehensive score ranking of Hebei Province.

Table 4 Comprehensive score of rural circular economy in cities of Hebei Province, China

Area	Score of F_1	Score of F_2	Score of F_3	Score of F_4	Score of F_5	Comprehensive score
Shijiazhuang City	1.29	1.43	0.51	−0.17	−1.43	0.76
Tangshan City	0.45	1.65	−1.03	−0.02	0.66	0.39
Qinhuangdao City	0.01	0.11	1.18	1.35	1.17	0.40
Handan City	0.29	0.14	0.31	−2.06	0.78	0.08
Xingtai City	0.54	−0.77	1.21	0.49	0.69	0.31
Baoding City	0.18	−0.66	0.30	−1.16	−0.42	−0.14
Zhangjiakou City	−1.68	−0.54	1.04	−0.38	−1.15	−0.64

2.3 Analysis of index factor Comprehensive index of rural circular economy is a dynamic and relative concept. Although calculation result of rural circular economy in 11 cities of Hebei Province is not always very accurate, Table 4 can basically show the development status and differences of rural circular economy in different areas.

(1) Shijiazhuang, Qinghuangdao and Tangshan Cities have the highest comprehensive score. Scores of F_1 and F_2 in

Shijiazhuang City is relatively high, indicating that circular economic development of rural Shijiazhuang is mainly reflected in the agricultural production and rural life circulation. Scores of F_3, F_4 and F_5 in Qinghuangdao City are relatively high, but those of F_1 and F_2 are relatively low. There are few villages around Qinghuangdao City, which offer services for Qinghuangdao and have strong industrial driving character. Besides, development degree of production and life circular is low in rural areas. Score of F_2 in Tangshan City is relatively high, indicating that circular economic development in rural Tangshan City has the major features of high rural life circular and strong government support[2].

(2) Comprehensive scores of Xingtai, Handan, Langfang, Baoding, Cangzhou are at the middle level. Among them, Xingtai, Handan and Baoding, mainly located in the plain area, are both traditional farming area and major grain producing area in Hebei Province. In these areas, there are relatively good agricultural natural conditions, many rural employees, large amount of rural fixed assets, and great total output of rural society. According to the scores, F_1, F_3, F_4 and F_5 in Xingtai City are higher than the other two areas. And F_3 in both Handan and Baoding Cities have certain advantages. Development of rural circular economy in Langfang City is mainly reflected in factor F_4, that is, farmers' education quality factor. Since the rural area of Langfang City is near Beijing and Tianjin, education degree of farmers is relatively high due to the impact of the two cities. Large cities have a powerful effect on stimulating the demand for agricultural products, which objectively promotes the development of the agricultural industrial chain. F_5 of Cangzhou City is relatively high and other factors are relatively low, indicating that except the environmental protection, situation of rural circular economic development is not optimistic.

(3) Comprehensive scores of Hengshui, Chengde, and Zhangjiakou are at a relatively low level. Score of F_1 in Hengshui City is relatively higher than the other two areas, as well as the scores of F_2 in Chengde and F_3 in Zhangjiakou. Rural circular economic development is relatively slow in these three areas.

3 Cluster analysis of rural circular economy in areas of Hebei Province

Between-groups Linkage is adopted to conduct Hierarchical Cluster Analysis on index data in 11 areas of Hebei Province[3]. Thus, dendrogram of hierarchical cluster analysis is obtained (Fig. 1).

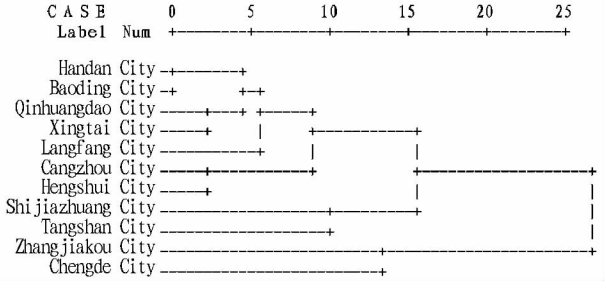

Fig. 1 Dendrogram of hierarchical cluster analysis

Fig. 1 illustrates that Handan, Baoding, Qinhuangdao, Xingtai, Langfang, Cangzhou and Hengshui belong to the first class; Shijiazhuang and Tangshan belong to the second class; and Zhangjiakou and Chengde belong to the third class. Among them, Handan and Baoding in the first class are close to each other; and Qinghuangdao and Xingtai are relatively close, as well as Cangzhou and Hengshui. Therefore, classification of rural circular economic status in Hebei Province is firstly determined by the proximity of geography and landscape feature, such as Baoding and Handan, Zhangjiakou and Chengde, Cangzhou and Hengshui. Secondly, classificatiion is determined by the status of industrial development, such as in Shijiazhuang and Tangshan.

4 Countermeasures for promoting the development of rural circular economic development

4.1 Increasing governments' input in construction of rural circular economy In the aspect of investment expenditure of rural circular economy, government should increase the input, promote the supporting public facilities which are conducive to the development of rural circular economy, such as construction of rural circular economic and ecological park, large hydropower project, and large biogas pool. In the aspect of consumption expenditure, government should promote the recycle utilization of market through green purchase behavior, highlight the participation of agricultural enterprise, peasant household and provincial and local governments, exert the enthusiasm of local government, enterprise and peasant household to the maximum limit, and implement financial subsidy. On the one hand, government offers subsidy for the pollution reduction of township enterprises. On the other hand, government uses "three wastes" of township enterprises and products from circular mode of agricultural production resources to offer preference such as tax reduction and exemption[2,4].

4.2 Promoting the development of rural circular economy from the aspect of industrial policy According to the judging criteria of rationalization of industrial structure, two indices should be placed in a more important role, including rational use of rural resources and the protection of rural ecological environment. During the industrial restructuring and upgrading, we should take rural recycling industry as the preferential developmental industry and actively promote the development of rural recycling industry in industrial restructuring and upgrading. At the same time, we should support the extension of rural recycling technology in the technology policy of industrial development, and give aid to rural recycling technology in industrial trade policy.

4.3 Promoting the construction of rural circular economic market in adjacent areas Since there is certain similarity in the development of rural circular economy in adjacent areas, relatively large agricultural resource, waste resources and other trading markets should be gradually established within the regional range. The key of benign development of rural circular economy is to form a resource allocation mechanism having greater reliance on market operation. Connecting circular econ-

omy by market economy can save resources, protect environment, and reduce transaction cost. Rural circular economy is not only an economic activity needing rural input, but also has huge profit space. In the aspect of value activity attribute and value composition, rural circular economy market should be established based on the following conditions. Firstly, cultivate the market subject, encourage township enterprises and farmers to develop circular economy, and make rural recycling of resource and environmental-friendly township enterprise profitable. Secondly, clearly establish property and the peasants' ownership of land, water and mineral; and the use right of license, management right, concession, and development right. Thirdly, conduct reasonable pricing. Only when the resources price is reasonable, can producers reach tradeoff correctly between natural resources and "reduction, recycling, reuse", so as to compare the recycled materials and raw materials and to find out a scheme most suitable for "cost-benefit".

4.4 Implementing mandatory public participation Self-conscious public participation is based on the high awareness of sustainable development of the public. However, the farmers' awareness of sustainable development is relatively low in Hebei Province, and mandatory public participation is necessary. In-depth investigation and feasibility study should be conducted before the implementation of mandatory public participation. Besides, we should carry out consultation on all parties, define precise program to obtain efficient results, define the concept of circular economy public, and accelerate the development of circular economy[2].

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河北省农村循环经济发展水平测评

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摘要 根据农村数据的可得性,立足各地区经济发展实际情况,选取1个1级指标、4个2级指标、20个3级指标建立农村循环经济发展水平测评指标体系。依据相关数据,将数据进行标准化处理,采用因子分析法对河北省各地区循环经济水平测评发现:石家庄市、秦皇岛市和唐山市综合得分最高;邢台市、邯郸市、廊坊市、沧州市和保定市综合得分处于中等水平;衡水市、承德市和张家口市综合得分处于低水平。同时,对标准化的数据进行聚类分析发现,邯郸市、保定市、秦皇岛市、邢台市、廊坊市、沧州市和衡水市为第1类,石家庄市、唐山市为第2类,张家口市、承德市为第3类,这反映河北省各地区农村循环经济状况取决于地理上的接近和地貌特点的近似性。提出了增加政府对农村循环经济的建设的投入、从产业政策视角促进农村循环经济发展、促进相邻地区农村循环经济市场建设、实行强制性公众参与相关建议,以期实现农村经济、社会与环境和谐发展,推进社会主义新农村建设进程。

关键词 农村循环经济;因子分析;聚类分析;中国河北

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中国农业经营组织化的发展困境和路径选择

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摘要 介绍了农民组织和中国农业经营组织化的基本内涵,分析了农业经营组织化的重要性。提出了我国农业经营组织化面临的发展困境,即思想认识不到位,组织发展不平衡;农业经营组织规模较小,带动效应不明显;组织规范化程度不高,运行效率较低;相关支持系统不健全,运行成本过高。基于此,提出了提高我国农业经营组织化程度的对策建议:一是加大宣传和教育力度,努力转变对农业经营组织的认识;二是深化市场化改革,提高信息服务能力,增强农业经营组织的规范性;三是拓宽农产品价值链,构建合意农业组织载体,保证农民的利益;四是完善多种运行机制,多渠道推进中国农业经营组织化的进程。

关键词 农业经营组织化;合意组织;路径选择