AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

On the Poverty in the Rocky Desertification Areas of Southwest China Based on AHP: A Case Study of Liupanshui City in Guizhou Province

Haibin ZHU, Xiaodong REN*

1. Institute of South China Karst, Guizhou Normal University, Guiyang 550001, China; 2. The State Key Laboratory Incubation Base for Karst Mountain Ecology Environment of Guizhou Province, Guiyang 550001, China

Abstract Karst rocky desertification mountain areas are regarded as main positions to wipe out poverty for their large poverty population, wide poverty area, high rate of poverty, etc. This paper takes Liupanshui city as an example where the situation of rocky desertification is very serious. We build the indicator system of poverty alleviation and development by analyzing their poverty and using the AHP method and also find the limiting factors which restrict the development of this area then put forward the recommendations to alleviate poverty.

Key words AHP, Rocky desertification areas, Poverty, Liupanshui City

Southwest karst areas are the most concentrated contiguous areas featuring karst landform in China. Due to fragile ecological environment, it was identified as one of the eight ecologically fragile areas - the southwest ecologically fragile karst area with rocky desertification, in the National Program for Ecologically Fragile Area Protection introduced by the Ministry of Environmental Protection in 2008[1]. In the ecologically fragile environment coupled with traffic inconvenience, lack of information, backward agricultural production technologies and other social factors, the severe problems exist here, such as low level of per capita income, wide area of poverty, a large population in poverty, high incidence of poverty and high rate of falling back to poverty[2-4]. All these can trigger a vicious cycle "population increase-excessive reclamation - vegetation destruction-economic backwardness-living in poverty - low education levels - population increase"[5].

Southwest rocky desertification contiguous area with special difficulties is one of the fourteen contiguous destitute areas, which is designated by the State Council. Extending across Yunnan, Guizhou and Guangxi, the region covers an area of 228000 square meters, and becomes the major battlefield for a new round of poverty alleviation in China, with a total of 91 poverty-stricken counties (cities, regions) included in the planning list.

This article selects Liupanshui most widely distributed with rocky desertification as the research sample. Through the study of the sample city, we aim at finding out the bottleneck in its development and putting forward recommendations for poverty reduction so as to provide a theoretical basis for the development of Liupanshui City. Meanwhile, other southwest rocky desertification areas can draw lessons from it for further development.

Received: May 12, 2014 Accepted: June 12, 2014
Supported by National Natural Science Foundation of China (71163007); National Science and Technology Project in the Twelfth Five-Year Plan Period (2011BAC09B01).
* Corresponding author. E-mail: renxiaodong@hotmail.com

1 Overview of the study area

Liupanshui is a city in western Guizhou province, People's Republic of China. The name Liupanshui combines the first character from the names of each of the city's three constituent counties: Liuzhi, Pan, Shuicheng. As a prefecture-level city with an area of 9965 square kilometers, Liupanshui has a total population of 3100000, making it the second largest in the province. The city is known locally as "The Cool City" or "Cool Capital" due to its low average summer temperature.

It is an important node in the combined area of four provinces (Yunnan, Sichuan, Guizhou and Guangxi), and also an important part of "Panxi-liupanshui Resource Comprehensive Development Zone". Liupanshui City is rich in mineral resources, and it is an important resource reserve and supply base in Southwest China.

Liupanshui City has superior geographical advantages and rich natural resources, but due to the karst mountains and high degree of rocky desertification, the poverty problem is outstanding. There are 50 key development-oriented poverty alleviation counties in Guizhou Province at the new stage, 3 of which in the 4 administrative districts (Liuzhi Special District, Shuicheng County and Pan County) under the jurisdiction of Liupanshui City are listed as key development-oriented poverty alleviation counties.

According to the latest statistics of Liupanshui Municipal Bureau of Poverty Alleviation and Development, there are a total of 975200 rural poor people in Liupanshui City, and the rural poverty rate is 38.3%, accounting for 8.49% of rural poor people and 114.67% of the rural poverty rate in Guizhou Province, respectively. According to the national classification standard of poverty, the number of three types of poor townships in Liupanshui City is shown in Fig. 1.

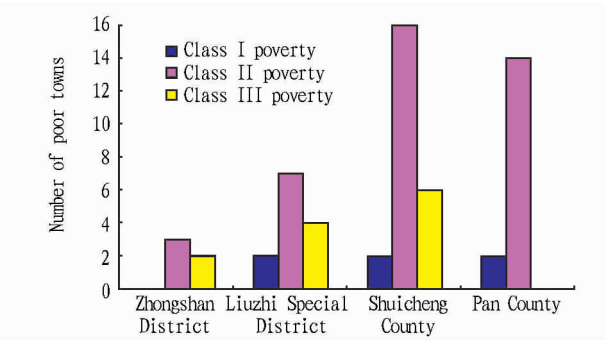

Fig. 1 The number of three types of poor areas in Liupanshui City

In Zhongshan District, the poor townships account for 55.56% of the total townships in the district. There are a total of 30 poor villages in the district, accounting for 56.61% of the total administrative villages. In 2011, the region's rural per capita net income was 5789 yuan, only equivalent to 82.97% of the national average (6977 yuan). According to the new national poverty standard, there are 47605 farmers with the per capita net income of below 2300 yuan and the poverty incidence is 29.1%.

In Liuzhi Special District, the poor townships account for 68% of the total townships in the district. There are a total of 229 poor villages in the district, accounting for 58% of the total administrative villages. In 2011, the region's rural per capita net income was 4026 yuan, only equivalent to 57.70% of the national average. According to the new national poverty standard, there are 190900 farmers with the per capita net income of below 2300 yuan and the poverty incidence is 33.8%.

In Shuicheng County, the poor townships account for 72.73% of the total townships in the district. There are a total of 220 poor villages in the district, accounting for 72.85% of the total administrative villages. In 2011, the region's rural per capita net income was 4010 yuan, only equivalent to 57.47% of the national average. According to the new national poverty standard, there are 347000 farmers with the per capita net income of below 2300 yuan and the poverty incidence is 45.4%.

In Pan County, the poor townships account for 43.24% of the total townships in the district. There are a total of 308 poor villages in the district, accounting for 68.4% of the total administrative villages. In 2011, the region's rural per capita net income was 4305 yuan, only equivalent to 61.70% of the national average. According to the new national poverty standard, there are 389700 farmers with the per capita net income of below 2300 yuan and the poverty incidence is 37%.

2 Building the evaluation model for development-oriented poverty alleviation using AHP

Liupanshui City is rich in mineral resources, but there is the phenomenon of "robust finance but poor people" in such region[6]. In order to systematically and hierarchically analyze the causes of this phenomenon[7], this paper uses AHP (Analytic Hierarchy Process) to build the development-oriented poverty alleviation evaluation indicator system, to analyze the current situation of poverty in the regions under the jurisdiction of Liupanshui City. It is conducive to the comprehensive consideration of the relationship between various systems so that the development-oriented poverty alleviation more targeted.

2.1 Building the evaluation indicator system for development-oriented poverty alleviation The sluggish economic development and poor people's living standards in the rocky desertification areas are the result of many factors. Economy, society and ecology are the three core indicators which reflect the sustainable development in an area.

This paper divides the evaluation indicator system for regional development-oriented poverty alleviation into the following three layers:

(i) The first layer is the goal layer where there is one indicator, namely the evaluation indicator system for regional development-oriented poverty alleviation.

(ii) The second layer is the criteria layer where there are three indicators, including three subsystems (economy, society and ecology).

(iii) The third layer is the indicator layer where there are 18 specific indicators highly correlated with poverty levels, affiliated with the three sub-categories of the criteria layer according to the category.

2.2 Building the comparison matrix and calculating the weight of various layers of indicators In this paper, this paper uses the Delphi method to build comparison matrix.

In the first place, there is a need to carry out the pairwise comparison of various layers of indicators, and determine the weight of the indicator relative to the indicators in the upper layer based on its importance. In order to carry out the quantitative description of the importance of various indicators in the matrix, there is a need to introduce the matrix judgment scale (1-9 scale method)[8], and assign the value based on the importance (importance degree gradually increased from "1" to "9")[9].

In the second place, it is necessary to ensure that the matrix is the positive reciprocal matrix with diagonal product of 1. The calculated weight of criteria layer and indicator layer is shown in Table 1.

2.3 Consistency test of comparison matrix The comparison matrix built using AHP is usually inconsistent, but in order to use the eigenvector corresponding to the largest eigenvalue as the weight vector of the factors to be compared, so there is a need to carry out consistency test of comparison matrix[10].

The method for consistency test of comparison matrix is as follows: Let λ_{max} be the maximum eigenvalue of the comparison matrix, and n be the sum of diagonal elements of comparison matrix. The consistency indicator $CI = (\lambda_{max} - n)/(n-1)$, the value of average random consistency indicator RI can be derived from the table, and the consistency ratio $CR = CI/RI$. When $CR < 0.1$, it shows that the comparison matrix passes the consistency test.

In the first layer (AB), the weight of economic system, so-

cial system and ecosystem relative to the goal layer is 0.633 7, 0.191 9 and 0.174 4, respectively, and the consistency test result is as follows:

$CI = 0.008\ 8$, $RI = 0.580\ 0$, $CR = 0.015\ 2 < 0.1$, $\lambda_{max} = 3.009\ 2$.

It indicates that the comparison matrix satisfies consistency.

In the second layer ($B_1 - C$), the weight of 8 indicators is 0.271 4, 0.071 9, 0.042 1, 0.145 9, 0.078 4, 0.078 4, 0.122 7 and 0.189 2, respectively. The consistency test result is as follows:

$CI = 0.013\ 2$, $RI = 1.410\ 0$, $CR = 0.009\ 4 < 0.1$, $\lambda_{max} = 8.130\ 2$.

It indicates that the comparison matrix satisfies consistency.

Similarly, the consistency test result in the second layer ($B_2 - C$) is also obtained as follows:

$CI = 0.006\ 6$, $RI = 1.240\ 0$, $CR = 0.005\ 3 < 0.1$, $\lambda_{max} = 6.0415$.

It indicates that the comparison matrix satisfies consistency.

The consistency test result in the second layer ($B_3 - C$) is as follows:

$CI = 0.003\ 9$, $RI = 0.900\ 0$, $CR = 0.004\ 3 < 0.1$, $\lambda_{max} = 4.010\ 4$.

It indicates that the comparison matrix also satisfies consistency.

Table 1 The evaluation indicator system for the regional development-oriented poverty alleviation

Goal	Criteria	Weight	Indicators	Weight
The evaluation indicator system for the regional development-oriented poverty alleviation (A)	Economic system (B_1)	0.633 7	GDP (C_1) //10^4 yuan	0.271 4
			Per capita GDP (C_2) //yuan	0.071 9
			Farmers' per capita net income (C_3) //yuan	0.042 1
			Fixed assets investment (C_4) //10^4 yuan	0.145 9
			General budget revenue (C_5) //10^4 yuan	0.078 4
			General budget expenditures (C_6) //10^4 yuan	0.078 4
			The proportion of the secondary industry (C_7) //%	0.122 7
			The proportion of the tertiary industry (C_8) //%	0.189 2
	Social system (B_2)	0.191 9	Total population at the end of the year (C_9) //10^4 people	0.174 9
			Total retail sales of consumer goods (C_{10}) //10^4 yuan	0.302 2
			Above-scale industrial added value (C_{11}) //10^4 yuan	0.319 6
			Total output value of farming, forestry, animal husbandry and fishery (C_{12}) //10^4 yuan	0.081 7
			Food production (C_{13}) //t	0.076 4
			Per capita share of grain (C_{14}) //kg	0.045 2
	Ecosystem (B_3)	0.174 4	The area of commonly cultivated farmland (C_{15}) //ha	0.344 8
			Woodland area (C_{16}) //ha	0.185 2
			Forest coverage (C_{17}) //%	0.370 5
			Total energy consumption for regional production (C_{18}) //t ce/10^4 yuan	0.099 5

2.4 Normalization of the indicator layer data In the evaluation indicator system, the original dimensions of the selected indicators are inconsistent, and the indicators can not be directly calculated, so it is necessary to normalize the indicators. In this paper, we use the extreme value method to conduct the dimensionless processing of the original indicators[11]. The direct indicator is as follows:

$$Z_{ij} = (X_{ij} - \min_i X_{ij}) / (\max_i X_{ij} - \min_i X_{ij}),\ i = 1, 2, \cdots, m;\ j = 1, 2, \cdots, n.$$

where Z_{ij} is the normalized value of sample; X_{ij} is the original value of indicator; $\max_i X_{ij}$ is the maximum value of sample; $\min_i X_{ij}$ is the minimum value of sample.

The values before and after normalization are shown in Table 2.

Table 2 The values before and after normalization of original data

Indicators	Original indicator data				Dimensionless indicator data			
	Zhongshan District	Liuzhi Special District	Shuicheng County	Pan County	Zhongshan District	Liuzhi Special District	Shuicheng County	Pan County
C1	2 182 987	678 722	890 583	2 499 770	0.826 0	0	0.116 3	1
C2	35 312	13 723	12 649	24 145	1	0.047 4	0	0.507 3
C3	5 789	4 026	4 010	4 305	1	0.008 9	0	0.165 8
C4	1 120 785	502019	956 755	1 653 224	0.537 5	0	0.395 0	1
C5	110 302	49850	98 937	258719	0.289 4	0	0.235 0	1
C6	189 019	215664	261 376	487 797	0	0.089 2	0.242 2	1
C7	1 221 187	330844	585 582	1 850 041	0.284 6	0	0.673 0	1
C8	941 704	277878	215 001	509 725	1	0.903 3	0.163 9	0
C9	61.88	49.36	70.29	103.47	0.2314	0	0.386 8	1
C10	873 439	195 945	92 208	414 477	1	0.132 8	0	0.4125
C11	746 488	150 196	658 513	1 264 882	0.534 9	0	0.4560	1

(To be continued)

(Table 2)

Indicators	Original indicator data				Dimensionless indicator data			
	Zhongshan District	Liuzhi Special District	Shuicheng County	Pan County	Zhongshan District	Liuzhi Special District	Shuicheng County	Pan County
C12	47 335	110 261	171 266	236 148	0	0.333	0.6564	1
C13	19 482	153 097	165 874	226 148	0	0.646 5	0.7084	1
C14	119	271	217	214	0	1	0.644 7	0.625
C15	3 373	25 829	33 097	45 842	0	0.528 8	0.699 9	1
C16	18 521.91	51 249.09	137 939	168 435.27	0	0.218 3	0.796 6	1
C17	30.4	33.00	36.63	39.00	0	0.302 3	0.724 4	1
C18	4.87	2.31	3.79	2.04	1	0.095 4	0.618 4	0

Note: The original data are from the statistics of *Guizhou Statistical Yearbook* (2012), Poverty Alleviation and Development Bureau of Liupanshui City, and Development and Reform Bureau of Liupanshui City.

2.5 Calculation of the total score of sample After the dimensionless processing of the original data, we can use the weighted summation formula to calculate the total score of each subsystem in accordance with the indicator system from bottom to top:

$$Q_i = \sum Z_{ij} C_j (i = 1, 2, \cdots, m; j = 1, 2, \cdots, n)$$ [12]

where C_j is the weight coefficient of the following layer indicator relative to the previous layer indicator.

By the weighted summation, we can derive the subsystem scores and overall strength scores of the comparison samples, and the comparison results are shown in Table 3.

Table 3 Comparison of the comprehensive regional development indicators in Liupanshui City

Regions	Economic system	Social system	Ecosystem	Overall strength	Overall ranking
Zhongshan District	0.420 40	0.098 56	0.017 35	0.536 31	2
Liuzhi Special District	0.115 13	0.031 08	0.060 04	0.206 25	4
Shuicheng County	0.152 21	0.067 22	0.125 35	0.344 78	3
Pan County	0.469 09	0.154 58	0.157 05	0.780 72	1

3 Evaluation of the study results

3.1 Analysis of economic system In terms of economic development, the economy of Pan County is the strongest, followed by Zhongshan District, and the economy of Shuicheng County and Liuzhi Special District is weaker. From the specific indicators, Pan County has the highest GDP, followed by Zhongshan District, Shuicheng County and Liuzhi Special District, and the GDP of the four regions accounts for 40.72%, 35.56%, 14.51% and 11.06% of the total GDP of Liupanshui City. From the per capita GDP and farmers' per capita net income, the two indicators in Zhongshan District and Pan County are higher than in Liuzhi Special District and Shuicheng County.

In terms of the fixed assets investment, the total investment in Pan County and Zhongshan District is high, while the total investment in Shuicheng County and Liuzhi Special District is low, only equivalent to 57.87% and 30.37% of total investment in Pan County, respectively, indicating that the growth momentum of reproduction of fixed assets is weak in Liupanshui City.

In terms of the industrial structure, the GDP of the three industries in Liupanshui City accounts for 5.2%, 62.7% and 32.1% of total GDP, and the proportion of primary industry and tertiary industry significantly lags behind secondary industry, indicating that the industrial structure is not sound in Liupanshui City, and it needs further adjustment.

3.2 Analysis of social system In terms of the social system, Pan County and Zhongshan District rank in the forefront, Shuicheng County ranks third, and Liuzhi Special District ranks last. From the total retail sales of consumer goods, Zhongshan District and Pan County are the highest, while Liuzhi Special District and Shuicheng County are weak.

However, there are large differences between them, and especially the total retail sales of consumer goods in Shuicheng County are only equivalent to 5.85% of the city level, indicating that the purchasing power of goods is weak in Shuicheng County, and the material and cultural living standards of residents need to be improved.

In terms of the above-scale industrial added value, it grows rapidly in Pan County, while Liuzhi Special District lags behind, equivalent to only 11.87% of that of Pan County, indicating that the scale of investment in Liuzhi Special District still needs to be expanded, and there is an urgent need to introduce new strategic industries to support the development of the region.

From the food production and per capita share of grain, the overall output value and owning amount are low, and especially for Zhongshan District, the per capita share of grain is the lowest, equivalent to only 28.07% of the national average (424 kg).

3.3 Analysis of ecosystem In the ecosystem criteria layer, Pan County ranks first, followed by Shuicheng County, Liuzhi Special District and finally Zhongshan District. In terms of the energy consumption per unit of GDP, the total energy consumption is the highest in Zhongshan District, and 4.87 tons of standard coal will be consumed per 10000 yuan of GDP, equivalent to 171.89% of the city's energy consumption (2.8332 tons); the total energy consumption is the lowest in Pan County, equivalent to only 14.89% of that of Zhongshan District, indicating that Zhongshan District is facing severe ecological problems, and low levels of energy efficiency.

In terms of woodland area and forest coverage, Pan County is the highest, while Zhongshan District is the lowest, but the overall

level of the city is low, which also explains the reason for the prominent rocky desertification in the region.

3.4 Analysis of comprehensive strength Through the analysis of three systems in the criteria layer, it is found that the regional development is good in Pan County, followed by Zhongshan District, and finally Shuicheng County and Liuzhi Special District. As the strong economic counties in Guizhou Province, Pan County and Zhongshan District should give full play to the role of regional economic growth pole in driving the economic development of the surrounding areas; Shuicheng County and Liuzhi Special District should speed up industrial restructuring based on their own advantages to achieve rapid economic development.

4 Recommendations

4.1 Crystallizing the regional positioning and creating economic growth pole In *Regional Development and Poverty Alleviation Plan for the Rocky Desertification Areas of Yunnan, Guizhou and Guangxi* (2011 – 2020) promulgated by the State Council, Liupanshui City is regarded as the main battlefield for poverty alleviation, and in the spatial structure of "Eight Centers, Six Corridors", it is not only one of the "Eight Centers", but also an important node city in the "Six Corridors".

Based on their own geographical advantages, Liupanshui City should rely on Guiyang – Kunming Railway, Neijiang – Kunming Railway, and other major arterial trunks as well as GZ65 National Highway and other highways to speed up the development of central cities and the clustering of industries along the line; enhance the leading role of "Panxi-liupanshui Development Zone", actively promote the interaction between this region and other regions (such as Central Yunnan Economic Zone; Chengdu – Chongqing Economic Zone; Central Guizhou Economic Zone; Beibu Gulf Economic Zone), and highlight the "economic engine" role of Liupanshui City in Southwest China.

4.2 Adjusting the industrial structure to achieve comprehensive upgrading The optimization of the industrial structure is the core of structural change in the social productive forces, and as a resource converter[13], it drives the transfer of labor, labor materials and other economic resources between the three industries, to make the industrial structure become more rational. In the current industrial structure of Liupanshui City, the secondary industry occupies the largest proportion, and the primary and tertiary industries lag behind.

In the future, it is necessary to rely on the strength of secondary industry, to form the advantage complementation between industries and achieve the coordinated development of three industries; fully tap the economic growth point of the tertiary industry based on the market, according to market demand.

Meanwhile, relying on abundant coal resources, it is necessary to focus on the development of energy, equipment manufacturing, coal chemical industry, trade logistics and other pillar industries, and establish an industry system platform based on ecological agriculture with mineral economy as the center.

4.3 Seizing the policy opportunities to enhance the coordinated development In order to promote balanced regional development and strengthen the development-oriented poverty alleviation, the State Council issued some important documents such as *China Rural Poverty Alleviation and Development Program* (2011 – 2020), and *Several Opinions on Further Promoting Sound and Rapid Economic Development in Guizhou Province*[14].

Liupanshui City should fully tap the favorable policies based on resource carrying capacity, environmental carrying capacity and population carrying capacity, to promote the development of recycling economy, and build Liupanshui City into a demonstration area of circular economy in Southwest China. At the same time, it is necessary to increase efforts to support poor towns, rely on the government to implement the preferential agricultural policies for the purpose of sound and rapid economic development in Liupanshui City.

4.4 Seeking both temporary and permanent solutions to break the vicious cycle of poverty[15] Regional poverty not only relies on the external aid but also relies on internal development. Poverty is a trap of vicious cycle of ecological environment[16]. The poverty results in the population explosion in the karst areas, while population explosion, in turn, leads to the rocky desertification in the karst areas.

In order to break the vicious cycle of poverty, on the one hand, it is necessary to strengthen the sustainable development education for farmers and the environmental monitoring of rocky desertification communities[17], enhance forest conservation, and change farmers' lifestyles and energy use structure in the rocky desertification areas; on the other hand, it is necessary to increase rocky desertification control, protect the areas where rocky desertification has not yet occurred, and comprehensively control the areas where rocky desertification has already occurred.

References

[1] The notice about issuing Protection Plan for the National Ecological Fragile Area[J]. The Bulletin of Ningxia Hui Autonomous Region People's Government, 2008(36): 27 – 34. (in Chinese).

[2] SU WC. Development-oriented poverty reduction model and lasting effect mechanism in concentrated Karst desertification extreme poverty areas of Yunnan, Guan-gxi and Guizhou Provinces[J]. Guizhou Science, 2012, 30(4): 1 – 5. (in Chinese).

[3] WU YX. The connotation and significance of poverty alleviation and development in Karst region in "Bijie pilot area"[J]. Journal of Guizhou Institute of Socialism, 2012(3): 23 – 27. (in Chinese).

[4] QING H. Analysis of the causes and countermeasures of the poor areas[J]. Journal of Inner Mongolia Normal University (Philosophy & Social Science), 2012, 41(5): 154 – 157. (in Chinese).

[5] HUANG CW. Environment, poverty alleviation and sustainable development—Study on Karst environmental restoration project mode of Australia – China Cooperative[M]. Beijing: China Archives Publishing House, 2006: 117 – 121. (in Chinese).

[6] WANG F. Regulating the profit of local government in mineral resources development[J]. China Mining Magazine, 2010, 19(2): 9 – 11, 18. (in Chinese).

[7] Zeki Aya, R. G. zdemir. A fuzzy AHP approach to evaluating machine tool alternatives[J]. Journal of Intelligent Manufacturing, 2006, 2(17): 179 – 190.

(To page 65)

(Continued Table 2)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Guizhou	1047.7923	1042.5998	1030.2234	1055.2168	1093.9476	1045.1371	1057.4824	1063.4690	1027.9800	1042.2357
Yunnan	1198.7608	1166.1510	1137.2375	1152.8736	1128.6333	1135.2466	1167.0948	1199.5937	1186.4715	1240.6038
Tibet	53.9963	56.2796	56.0280	54.2673	52.3198	49.5661	49.6543	51.1665	47.4696	55.7666
Shaanxi	700.5662	661.4844	654.5618	650.3628	638.2608	634.1490	630.4205	652.1591	651.8365	651.4056
Gansu	403.0873	396.7605	405.8502	405.6918	427.1990	441.7881	440.8939	496.2415	508.2110	539.0929
Qinghai	81.4522	89.9909	88.4123	89.3323	95.6736	97.1744	94.5751	92.4035	86.3367	91.2471
Ningxia	85.7273	81.0776	83.9606	84.1457	88.9108	91.5075	88.4002	88.2263	80.6361	85.0862
Xinjiang	-95.7810	-73.0057	-99.2052	-77.5873	-70.7653	-71.2054	-47.8264	-27.4452	-102.8750	-13.0030
Total	13747.96	12607.74	11102.77	11766.63	12214.88	12477.40	12449.53	13008.21	12042.20	13071.20

Note: The negative value in the table means that the agricultural labor is relatively insufficient.

3 Conclusions

When the agricultural production technical efficiency is very low, the output with the same amount of factor input is very low, or at the same level of output, the amount of factor input is excessive. Conspicuously, the excess amount of factors is closely related to the production technical efficiency. The excess amount of factors will increase along with the increased technical efficiency.

In other words, if output remains unchanged, with the increasing technical efficiency, the number of factors required will be smaller. In terms of the agricultural labor force, with the increasing agricultural production technical efficiency, the agricultural labor needed will be less and the surplus labor will be more. The existing calculation methods for the number of agricultural surplus labor all fail to reflect the impact of technical efficiency changes in the agricultural production on the surplus labor.

In this paper, we use the basic principle of stochastic frontier production function to calculate the agricultural production technical efficiency of various provinces and cities. And we select the province (Jiangsu Province) with the highest technical efficiency to assume that its agricultural labor is fully utilized, and there is no agricultural surplus labor.

With the ratio of agricultural labor number to agricultural output value in this province as a reference, we calculate the number of agricultural surplus labor in other provinces. It turns out that the national agricultural surplus labor is about 126 million in recent years. This calculation method makes up for the shortcomings of the existing calculation methods, and it reflects the relationship between the number of agricultural surplus labor and production technical efficiency.

References

[1] XIONG ZY, YU D. A shortcut to measure unemployment in China[J]. Statistical Research, 2004(7): 56-58. (in Chinese).

[2] National Bureau of Statistics. The quantitative research on surplus rural labor force

[J]. The World of Survey and Research, 2002(3): 18-21. (in Chinese).

[3] YANG DQ, HAN L. Measuring application efficiency of factors based on VES production function[J]. Science & Technology Progress and Policy, 2005, 22(1): 170-172. (in Chinese).

[4] WANG HL. A method to estimate the number of surplus labor force in our rural areas[J]. Statistical Research, 1998, 15(1): 48-50. (in Chinese).

[5] ZENG XY, WU YH, ZHENG DY. Random DEA model and its application [J]. Systems Engineering—Theory & Practice, 2000, 20(6): 19-24, 64. (in Chinese).

[6] Aigner, D. J., C. A. K. Lovell, P. Schmidt. "Formulation and estimation of stochastic frontier production function models"[J]. Journal of Econometrics, 1977: 6.

[7] Battese, G. E., T. J, Coelli. "Prediction of firm-level technical efficiencies with a generaliazed frontier production function and panel data"[J]. Journal of Econometrics, 1987: 38.

[8] XIAO D, HU HH. Data envelopment analysis and maximum likelihood estimation[J]. Systems Engineering Theory · Methodology · Applications, 1996, 5(1): 46-50. (in Chinese).

[9] LIU YS. Economic dualism[M]. Beijing: Economic Science, 1989. (in Chinese).

[10] John C. H. Fei. The development of labour surplus economy[M]. Beijing: Economic Science Press, 1992. (in Chinese).

[11] Yair Mundlak. Agriculture and economic growth: Theory and measurement [M]. Beijing: Economic Science Press, 2004. (in Chinese).

(From page 60)

[8] XU SB. Analytic hierarchy process[M]. Tianjin: Tianjin University Press, 1988: 8-13. (in Chinese).

[9] ChencHui Chou, Gin-shuh Liang, Hung-Chung Chang. A fuzzy AHP approach based on the concept of possibility extent[J]. Quality & Quantity, 2013, 1(47): 1-14.

[10] Ou Tong, Shuai Shao, *et al*. An AHP-based water-conservation and waste-reduction indicator system for cleaner production of textile-printing industry in China and technique integration[J]. Clean Technologies and Environmental Policy, 2012, 5(14): 857-868.

[11] ZHU CQ, XING YH. Construction, measurement, and improvement of China's material civilization index system[J]. Research on Financial and Economic Issues, 2009(7): 22-30. (in Chinese).

[12] NIU WP, CHEN YX. Evaluation on regional competitiveness of Guangdong Province based on the AHP method[J]. Journal of South China Agricultural University(Social Science Edition), 2007, 6(2): 40-46. (in Chinese).

[13] SUN ZL, LV XF. A ponderation on adjustment of rural industrial structure of the Wuling Mountain Area[J]. Social Science Journal of Shenyang Agricultural University, 2007, 9(6): 844-847. (in Chinese).

[14] SUN Q, CUI W, ZHOU PD, *et al*. SWOT analysis on rural poverty alleviation of Bijie experimental zone in the new period[J]. Guizhou Agricultural Sciences, 2011, 39(12): 262-267. (in Chinese).

[15] GAO GL, DENG ZM, XIONG KN. The ecological environment construction and sustainable development of Guizhou Karst: Karst's call and hope [M]. Guiyang: Guizhou Scientific and Technology Publishing House, 2003, 4: 87-89. (in Chinese).

[16] CHEN NY, ZHOU XD. Discussion on vicious circle of getting rid of poverty[J]. Inquiry Into Economic Issues, 2000(3): 34-37. (in Chinese).

[17] REN XD, GAO XC. The division of Karst environment and poverty type [J]. Rural Economy, 2010(2): 55-58. (in Chinese).