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AN ASSESSMENT FOR SUSTAINABLE DEVELOPING CAPABILITY OF INTEGRATED AGRICULTURAL REGIONALIZATION IN CHINA

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ABSTRACT: Based on the provincial units evaluation, this paper makes an assessment for sustainable developing capability of the integrated agricultural regionalization in China. At first, an index system of agricultural sustainable development in China is built up, which includes 5 supporting subsystems of agricultural resources, agricultural development, environment and ecosystem, rural society, sciences-education and management. We selected 95 factors on provincial level as basic indexes. Second, a relative assets/debt assessing method is used to gain relative net assets values (relative superiority) of every provincial unit, which are as supporting data for assessment. We also overlaid the Administrative Divisions Map of China and the Map of Integrated Agricultural Regionalization of China by Geography Information System (GIS) to gain the area units of assessment. Third, according to the relative coherence principle of regionalization, we transform administration units to natural units through homogenizing all provincial relative net assets values in every agricultural assessing unit. After making order and grade, we complete the sustainable developing capability assessment to integrated agricultural regionalization in China. The assessing outcome shows that the total sustainable agricultural developing capability of China is not high. Only about 1/3 in number or in area has reached the level of agricultural sustainable development. The relative net assets values exists a reducing trend from East China to West China. It needs a long period and great efforts to realize sustainable agricultural development over all China. Finally, there is a discussion to the study method.

KEY WORDS: assessment for agricultural sustainable development; integrated agricultural regionalization; China

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1 PREFACE

China is a large country in agriculture. The sustainable agriculture development in China is related to the national grain safety, ecological safety and the development of the whole national economy. But the question is how to evaluate and understand the sustainable capability of the agriculture, how to distinguish the difference and imbalance in different areas on the aspect of sustainable development, and then draw out the corresponding countermeasure. There are achievements coming out in recent years, such as "The sustainable development strategic report of China" (Sustainable Development Research Group of China, CAS, 2001); "Level and space characteristics of the regional sustainable development in China" (LIAO *et al.*, 2000) and "The regionalization of national rural economy" (GUO *et al.*, 1999). The above all take provincial units to research and evaluate. There are also some papers researched on the level of county such as "The ecosystem productivity rigionalization in China" (XU *et al.*, 2001) and "The spatial analysis of economical difference among counties on the 1990s in China" (LI *et al.*, 2001). In a word, from these outcomes having been published, the administrative areas are taken as the evaluation units. It is because that the actual statistical system in China is run as administrative units. And because sustainable development reflects an integrated ability, most basic data can be only acquired from the units of administrative area. If we e-

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valuate on the natural units, the supporting data about population, economy and society are difficult to get.

This paper tries to assess the sustainable developing capability of every regions of "the Integrated Agricultural Regionalization in China" (National Agricultural Regionalization Committee, 1987). This regionalization has been implemented for years and is rather authority. But its regional boundary line is not administrative. So how to evaluate the sustainable developing capability of the regions with the newest data is a difficult issue. This paper plans to reach the objective by two steps: evaluation of provincial agricultural sustainable developing capability and then transformation from the administrative units to natural units.

2 STUDY METHOD

2.1 Building Index System of Agricultural Sustainable Development

The agricultural sustainable development is supported by five systems: agricultural resources, agricultural development, environment and ecology, rural society as well as science, education and management. These five systems work jointly to support the sustainable development of agriculture. There are 95 indicators chosen.

2.2 Calculating the Capability of Agricultural Sustainable Development of Every Provincial Unit

This paper takes a evaluation method for relative sustainable developing capability by means of calculating assets/debt values (CAS, 2001) based on the data of provincial administrative units.

(1) Based on the theory of relative superiority, we compare the 31 provincial units (not including Hong Kong, Macao and Taiwan temporarily) to the 95 indicators one by one, and select the 10 most advanced (assets) and the 10 most backward (debts) to form the assets/debt matrix: $A = (a_{ij})_{31\times 95}$

(2) Defining the values of assets/debt

For assets, if the indicator has the order of 1, 2, 3...10, then it is endowed the value of 1.0, 0.9, 0.8, ..., 0.1; For debt, if the indicator has the order of 31, 30, 29..., 22, it is endowed the value of -1.0, -0.9, -0.8, ..., -0.1.

So the formula to calculate the total value of assets indicator of the supporting system x_i ($i = 1, 2, \cdots, 5$) is as follows:

$$x_i = (1 \times n_1 + 0.9 \times n_2 + \cdots + 0.1 \times n_{10})$$

in which, n_j is the number of homologous the assets indicator in the order of 1, 2..., 10 respectively.

The formula to calculate the total value of debts indicators of a supporting system y_i ($i = 1.2, \cdots\cdots, 5$) is as follows:

$$y_i = (-1.0 \times n_{31}) + (-0.9 \times n_{30}) + \cdots + (-0.1 \times n_{22})$$

in which, n_k is the number of the homologous debt item in the order of 31, 30, ..., 22 respectively.

(3) The calculating relative superiority (relative net assets)

The relative net assets is the sum of relative assets and relative debt, which means capability of comparative superiority.

The formula is:

$$B_i = (x_i/N_i + y_i/N_i) \times 100\% \quad (i = 1.2, \cdots\cdots, 5)$$

in which x_i is the total value of the assets indicators, y_i is the total value of the debt indicators, N_i is the total number of the source indicators in supporting system.

The relative net assets of a region, i.e. the overall capacity of comparative superiority of regional agriculture is:

$$C_p = (\sum X_{ip}/95 + \sum y_{ip}/95) \times 100\%$$

in which $i = 1, 2, \ldots, 5$, stands for different supporting system; $p = 1, 2, .., 31$ stands for different provincial units, ip is one supporting system within a provincial units.

If $C_i \geqslant 0$, the agricultural development is sustainable. If $C_p < 0$, the development is unsustainable.

2.3 Evaluating the Agricultural Sustainable Developing Capability of Sub-regions in the Integrated Agricultural Regionalization of China

(1) Due to the relative coherence principle of the integrated agricultural regionalization, every region or sub-region can be looked upon a relative homogeneous unit. But there are various provincial units in a sub-region with different agricultural sustainable developing capability. On the basis of the relative coherence, we can homogenize the net assets of interior provincial areas, which can express the agricultural sustainable developing capability of the sub-region. This assumption is tenable in theory. The homogenizing formula is:

$$D_m = \sum_{m=1}^{a} C_p \, S_{pm}/S_m$$

In the formula, D_m — relative net assets of an integrated agricultural region, stands for 9 first-level of regions or 38 second-level of sub-regions; C_p — every provincial net assets in this agricultural region; p is the

serial number of the relevant provincial units; S_{pm} — area of the p province in this agricultural region; a — the total number of provincial units in this agricultural region; S_m — area of this agricultural region.

(2) Using Geography Information System (GIS), we superpose the provincial administrative map on the integrated agricultural regionalization map and connect with the database. So we can calculate and display the relative net assets of every integrated agricultural region then assess out the grade of agricultural sustainable developing capability of every region.

3 EVALUATING INDEX SYSTEM OF AGRICULTURAL SUSTAINABLE DEVELOPING CAPABILITY IN CHINA

The index system of agricultural sustainable developing capability is made up of 5 supporting systems, 3 × 5 state level and 95 factor indicators (Fig. 1).

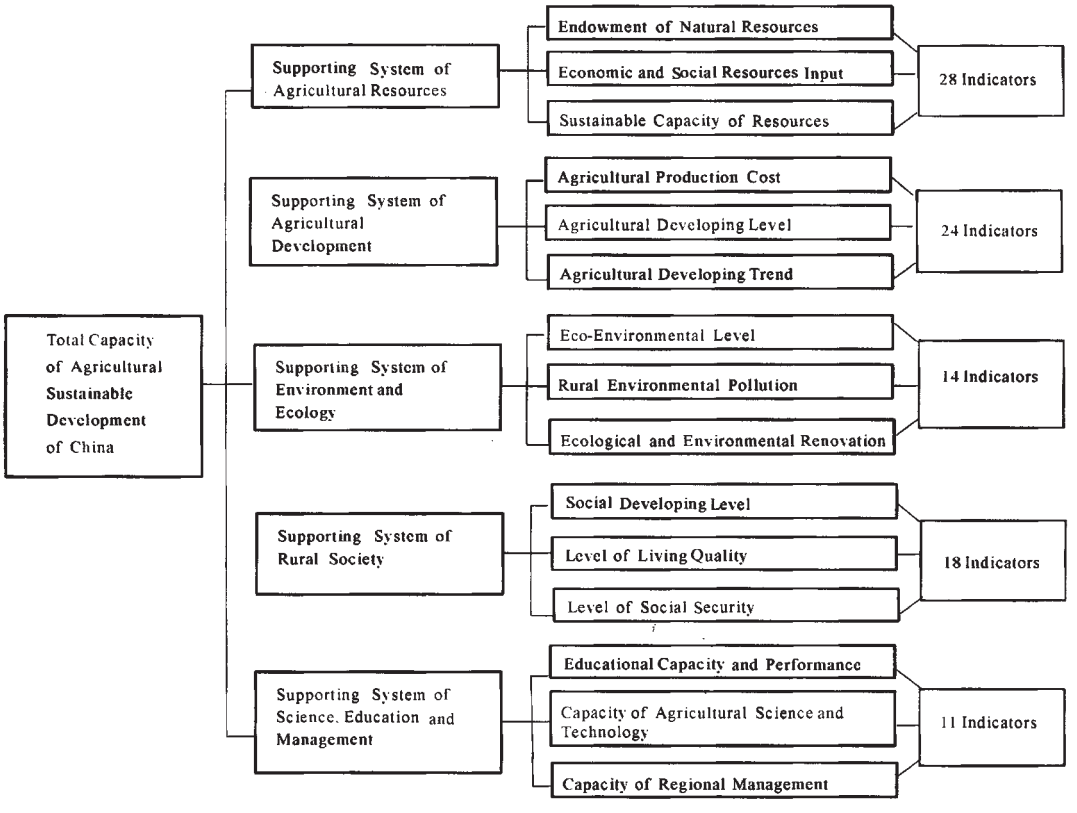


Fig. 1 Index system of agricultural sustainable development in China

4 SUPPORTING DATA AND BASIC MAPS OF EVALUATION

4.1 Calculation of Provincial Net Assets

The evaluating index data are collected mainly from statistics annuals and published works (Integrative Statistic Department of National Economy of National Statistics Bureau, 1999; National Statistics Bureau, 2000a, 2000b, 2000c; Committee of China Agricultural Almanac, 2000; Compiling Committee of Chinese Environmental Almanac, 2000; National Statistics Bureau, Ministry of National Science and Technology, 2000; Comprehensive Investigation Committee of CAS, 2000; Comprehensive Research Group of Important Natural Disasters of Chinese Science and Technology Committee, 1995; Sustainable Development Research Group of China, CAS, 1999, 2000, 2001).

According to the collected data, we can calculate the relative net assets of all provincial units by using the evaluating method of assets/debt relative sustainable developing. Then take them as the supporting data to assess the sustainable developing capability of the integrated agricultural regionalization in China. The difference among the provincial units is shown in the Fig. 2.

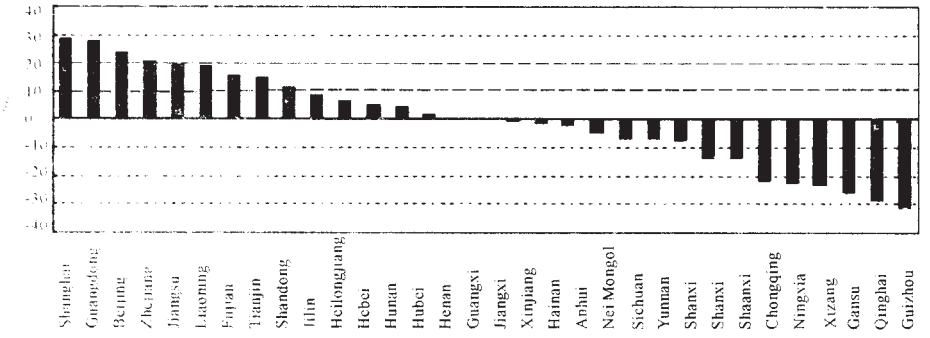


Fig. 2 Histogram of relative net assets of agricultural development at provincial level of China

4.2 Superposition of Administrative Divisions Map and Agricultural Regionalization Map

We can get the basic area units for evaluation when we superpose the administrative divisions map on the integrated agricultural regionalization map of China. (Fig. 3)

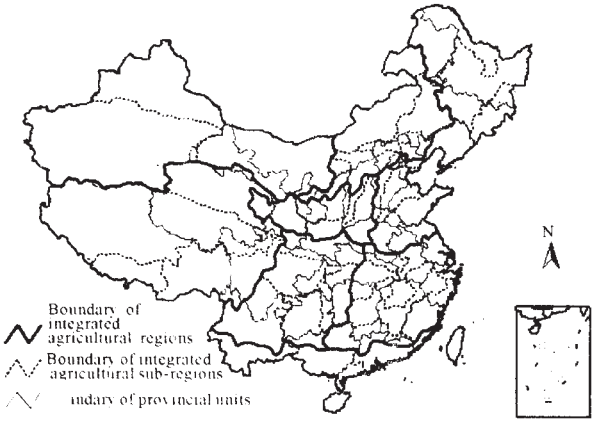


Fig. 3 Basic area units for evaluation of agricultural sustainable development in China

5 RESULTS OF EVALUATION

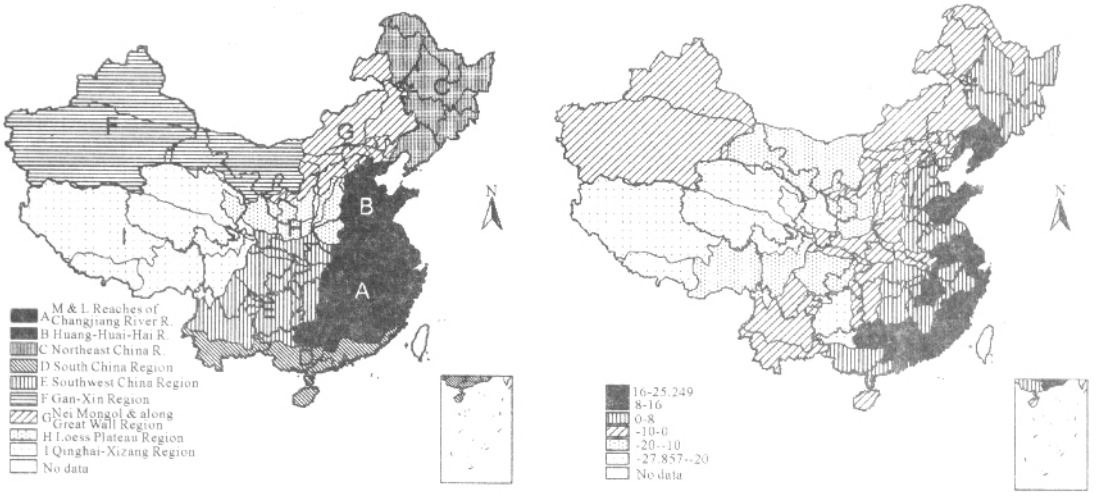
5.1 Order and Grade of Relative Net Assets Reflected Sustainable Developing Capability of Integrated Agricultural Regionalization

Using the method mentioned in section 2.3, we can calculate the value of relative net assets that reflected agricultural sustainable developing capability for every region and sub-region. There are 9 first level of regions with area. After homogenizing within every region, the value of relative net assets is from 7.216 to −22.744. In order to show the capability's difference among regions directly, we output the Order Map of Agricultural Sustainable Developing Capability by means of GIS (Fig. 4a). There are second level of 38 sub-regions whose net assets value is from 25.249 to −29.857. Because of many parcels, we disposed them by classifying and output the Grade Map of Agricultural Sustainable Developing Capability (Fig. 4b). The value of relative net assets $\geqslant 0$ means that the capability of this region is sustainable. And then, the region corresponding to the first-grade is stronger sustainable, the second-grade is sustainable and the third-grade is weakly sustainable. The value of relative net assets < 0 means unsustainable. And then, the region corresponding to the forth-grade is weakly unsustainable, the fifth-grade is unsustainable and the sixth-level is stronger unsustainable.

From the outcome of calculating the relative net assets and spatial distribution shown in Fig. 4, the regions that reach agricultural sustainable development in China centralize on east coastland and central transition zone. These regions cover less 1/3 area of China. But the vast west region is in agricultural unsustainable status. The sustainable capability ranges from high to low along the grads from the coastland to the inland. The sustainable capability is lowest in Loess Plateau and Qinghai-Xizang (Tibet) Plateau.

5.2 Integrated Regionalizing System Based on Evaluation of Agricultural Sustainable Developing Capability

We make respectively order for every first level of regions and second level of sub-regions according to the relative net assets' value and use GIS to get the assessment map. In which, A, B, C, ···, I express agricultural sustainable developing capability of the first-level of regions from high to low; a, b, c, d, e, f express value order of sub-regions within every region. And the current state of agricultural developing capa-



(a) Order of relative net assets of inteegrated agricultural regions (b) Grade of relative net assets of integrated agricultural sub-regions

Fig.4 Evaluation of relative net assets of sustainable development to the integrated agricultural zones in China

bility is expressed with 1, 2, 3, 4, 5, 6. For example, Gd4 means that the order of capability of the region is 7th among all regions, and the sub-region's order is 4th within this region as well as its agricultural development is in weakly unsustainable. The assessing result and integrated agricultural regionalization system according to the order of agricultural sustainable developing ca-pability are shown in Fig.5 and listed as follows.

A Region of the middle and lower reaches of the Changjiang River

Aa1 Zhe(Zhejiang)-Min(Fujian) hill and moun-tains sub-region suitable for forestry and farming in stronger sustainable development

Ab2 Nanling hills and mountains sub-region suit-able for forestry and farming in sustainable development

Ac2 Sub-region of plain and hill along the lower reaches of Changjiang River suitable for farming, animal husbandry and fishery in sustainable development

Ad3 Sub-region of the middle reaches plain of Changjiang River suitable for farming and fishery in

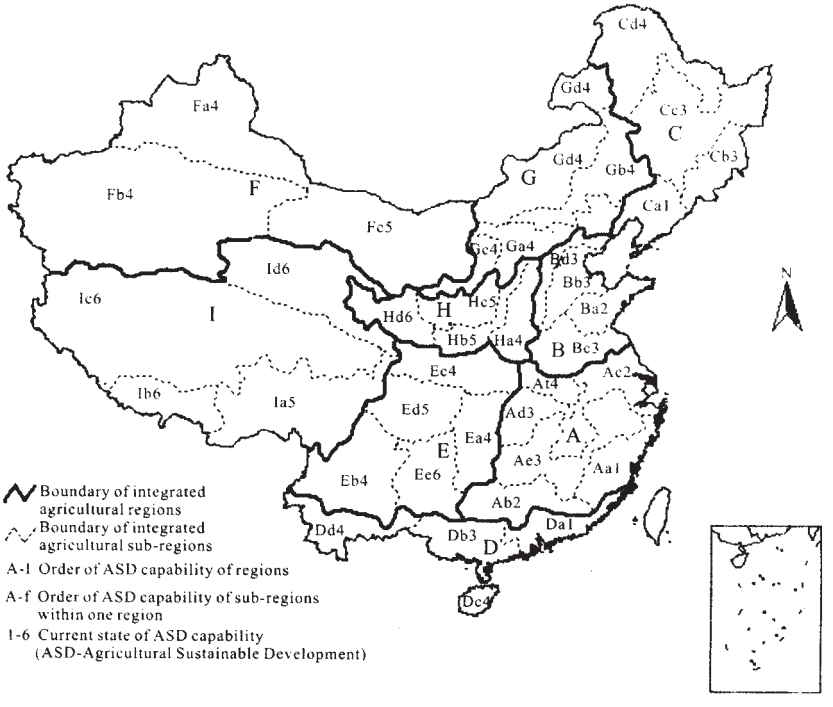


Fig.5 Assessment of sustainable developing capacity to the integrated agricultural regionalization of China

weakly sustainable development

Ae3 Jiangnan hill and mountains sub-region suitable for farming and forestry in weakly sustainable development

Af4 Yu(Henan)-E(Hubei)-Wan(Anhui)low mountains and plain sub-region suitable for farming and forestry in weakly unsustainable development

B Huang-Huai-Hai Region

Ba2 Shandong hills sub-region suitable for farming , forestry and fishery in sustainable development

Bb3 Ji(Hebei)-Lu(Shandong)-Yu(Henan) low-lying plains sub-region suitable for farming, animal husbandry and fishery inweakly sustainable development

Bc3 Huang-Huai plains sub-region suitable for farming and fishery in weakly sustainable development

Bd3 Sub-region of piedmont plains of Yanshan and Taihang Mountains suitable for farming in weakly sustainable development

C Northeast China Region

Ca1 Sub-region of hill and plain in Liaoning Province suitable for farming , forestry and fishery in stronger sustainable development

Cb3 Changbai Mountains sub-region suitable for forestry and farming in weakly sustainable development

Cc3 Songnen and Sanjiang plains sub-region suitable for farming in weakly sustainable development

Cd4 Da Hinggan Mountains sub-region suitable for forestry in weakly unsustainable development

D South China Region

Da1 Sub-region of South Fujian and central Guangdong Provinces suitable for farming, forestry and fishery in stronger sustainable development

Db3 Sub-region of west Guangdong and south Guangxi Provinces suitable for farming, forestry and fishery in weakly sustainable development

Dc4 Sub-region of Qiong(Hainan)-Lei(Leizhou) Peninsula area and other islands in South China Sea suitable for farming, forestry and fishery in weakly unsustainable development

Dd4 South Yunnan Province sub-region suitable for farming and forestry in weakly unsustainable development

E Southwest China Region

Ea4 Sub-region of mountains on the provincial border of Yu(Henan)-E(Hubei)-Xiang(Hunan)-Qian(Guizhou) suitable for forestry andfarming in weakly unsustainable development

Eb4 Sub-region of plateau and mountains of Sichuan and Yunnan Provinces suitable for farming, forestry and animal husbandry in weakly unsustainable development

Ec4 Qinling and Daba Mountains sub-region suitable for forestry and farming in weakly unsustainable development

Ed5 Sichuan basin sub-region suitable for farming and forestry in unsustainable development

Ee6 Sub-region of plateau and mountains in Guizhou and Guangxi Provinces suitable for forestry, farming and animal husbandry in stronger unsustainable development

F Gan(Gansu)-Xin(Xinjiang) Region

Fa4 North Xinjiang sub-region suitable for farming, animal husbandry and forestry in weakly unsustainable development

Fb4 South Xinjiang sub-region suitable for farming and animal husbandry in weakly unsustainable development

Fc5 Meng(Nei Mongol) -Ning(Xingxia) -Gan(Gansu) sub-region suitable for farming and animal husbandry in unsustainable development

G Region of Inner Mongolia and that along the Great Wall

Ga4 Sub-region along the Great Wall suitable for farming, forestry and animal husbandry in weakly unsustainable development

Gb4 Central Nei Mongol sub-region suitable for animal husbandry and farming in weakly unsustainable development

Gc4 South Nei Mongol sub-region suitable for animal husbandry and farming in weakly unsustainable development

Gd4 North Nei Mongol sub-region suitable for animal husbandry in weakly unsustainable development

H Loess Plateau Region

Ha4 Sub-region of hills and mountains in East Shanxi and West Henan Provinces suitable for farming, forestry and animal husbandry in weakly unsustainable development

Hb5 Fen(Fenhe) -Wei(Weihe) Valley sub-region suitable for farming in unsustainable development

Hc5 Sub-region of Jin(Shanxi)-Shan(Shaanxi) -Gan(Gansu) loess hills and valleys suitable for animal husbandry, forestry and farming in unsustainable development

Hd6 Sub-region of hills in Central Gansu and East Qinghai Provinces suitable for farming and animal husbandry in stronger unsustainable development

I Qinghai-Xizang (Tibet) Region

Ia5 Chuan(Sichuan)-Zang(Xizang) sub-region suitable for forestry, farming and animal husbandry in unsustainable development

Ib6 South Xizang sub-region suitable for farming and animal husbandry in stronger unsustainable development

Ic6 Qinghai-Xizang high and cold sub-region suitable for animal husbandry in stronger unsustainable development

Id6 Qing(Qinghai)-Gan(Gansu) sub-region suitable for animal husbandry and farming in stronger unsustainable development

6 CONCLUSION AND DISCUSSION

The Integrated Agricultural Regionalization of China worked out in the 1980's has played an important role in guiding allocation of agriculture and regional agricultural development.

This paper makes an assessment on sustainable development status of every integrated agricultural region by using the newest data. The assessing outcome shows:

(1) Generally, the agricultural sustainable developing capability in China is lower. In the first-level regions of integrated agricultural regionalization, the highest value of relative net assets is 7.216 and the lowest value of that is -22.744. In the 38 sub-regions, there are only 14 reaching agricultural sustainable development, occupying 36.8% of the total number. The rest 63.2% are unsustainable at different degree. In addition, the sustainable regions only cover about 1/3 area of China. It needs a long way and hard efforts to realize agricultural sustainable development over all China.

(2) The agricultural sustainable developing capability has a trend of transmeridional grads distribution in space. The regions that reach agricultural sustainable development distribute in the east coastland or central transition zone. They are all on the geomorphic third-ladder. Zhujiang River Delta, Zhe(Zhejiang)-Min(Fujian) coast area and Liaoning Plain are best; plain and hill in the lower reach of Changjiang River, Nanling area and Shandong Hill are better; the rest sub-regions are in weakly un sustainable status, which easy to turn to unsustainable status if developing disadvantageously. The central zone and Xinjiang region which are in weakly sustainable status, also covering 36.8% of sub-regions in number, which are easy to transform to sustainable status. So we should create good conditions to accelerate this process. Qinghai-Xizang Plateau, Qian(Guizhou)-Gui(Guangxi) Plateau and mountains, Loess Plateau, Meng(Nei Mongol)-Ning(Ningxia)-Gan(Gansu) animal husbandry and farming area are in unsustainable or strongly unsustainable status. These regions are main body of West China with vulnerable ecology, backward rural society and economy. We should firstly ensure the agriculture not to change worse, and then improve the sustainable developing capability step by step through solving key problems such as pasture retrogression, waterhead for irrigated farming, soil erosion in Loess Plateau、ecological reconstruction in Karst plateau and the methods to shake off poverty.

(3) Based on evaluation of provincial agricultural sustainable developing capability, this paper realized the assessment of that to the integrated agricultural regionalization of China by transforming the administrative units into natural units namely homogenizing relative net assets within integrated regions. The foundation of this work is relative coherence principle of regionalization. Viewing from the outcome of assessment, the general trend accords with reality and it is a feasible method. But it exists some apparent shortcoming too. For example, the original sustainable capability of Shanghai and Beijing is high. However, they became lower as the whole region after homogenizing. Above problem gives us the following revelation: First, in order to improve the accuracy of outcome we need to reduce in scale, either by depressing the level of administrative units, reducing area of units or by dividing the integrated regions further. Second, under new circumstance we should add some new types of zoning such as suburban farming area of metropolis, key developing area, representative vulnerable ecological area and so on. Thus the outcome of assessment can reflect modern agricultural characteristics. Third, well assessment depends on uniform data that can be used in both administrative units and natural units. It is necessary to set up grid data collecting system including natural-economic-social data and database that will cover whole country, so as to support assessment, monitoring and forecast for sustainable developing capability of agriculture or other aspects in China.

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REFERENCES

Committee of Agricultural Regionalization of China, Compiling

Committee of Chinese Agricultural Resources and Regionalization Outlines, 1987. *Chinese Agricultural Resources and Regionalization Outlines*[M]. Beijing: Surveying and Mapping Press, 1 – 255. (in Chinese)

Compile Committee of China Agricultural Almanac, 2000. *Chinese Agricultural Almana* [R]. Beijing: China Agricultural Press, 1 – 325. (in Chinese)

Compiling Committee of Chinese Environmental Almanac, 2000. *Chinese Environmental Almanac*[R]. Beijing: China Statistical Publishing House, 1 – 183. (in Chinese)

Comprehensive Investigation Committee of CAS, 2000. *The Notebook of Natural Resources of China*[M]. Beijing: Science Press, 1 – 228. (in Chinese)

Comprehensive Research Group of Important Natural Disasters of Chinese Science and Technology Committee, 1995. *Chinese Important Natural Disasters and Countermeasures (Annual Tables)*[M]. Beijing: Ocean Press, 1 – 323. (in Chinese)

GUO Huan-cheng, LI Jing-yi, 1999. *Regionalization of Rural Economics in China— Regional Development Research on Rural Economics in China*[M]. Beijing: Science Press, 1 – 621. (in Chinese)

Integrative Statistic Department of National Economy of National Statistics Bureau, 1999. *Collection of Statistic Data During 50 Years of New China*[R]. Beijing: China Agriculture Press, 1 – 890. (in Chinese)

LI Xiao-jian, QIAO Jia-jun, 2001. The spatial analysis of economical difference among counties on 1990s in China[J]. *Acta Geographica Sinica*, 56(2): 136 – 145. (in Chinese)

LIAO Zhi-jie, LIU Yue, 2000. Comprehensive Indexes and Spatial Distribution Characteristics of the Regional Sustainable Development of China[J]. *Acta Geographica Sinica*, 55(2): 139 – 150. (in Chinese)

National Statistics Bureau, 2000a. *Statistical Almanac of China* [R]. Beijing: China Statistical Publishing House, 1 – 200. (in Chinese)

National Statistics Bureau, 2000b. *Chinese Rural Statistical Almana*[R]. Beijing: China Statistical Publishing House, 1 – 208. (in Chinese)

National Statistics Bureau, 2000c. *China Population Statistical Almanac of China*[R]. Beijing: China Statistical Publishing House, 1 – 260. (in Chinese)

National Statistics Bureau, Ministry of National Science and Technology, 2000. *Chinese Statistical Almanac of Science and Technology*[R]. Beijing: China Statistical Publishing House, 1 – 196. (in Chinese)

Sustainable Development Research Group of China, CAS, 1999, 2000, 2001. *Report on Chinese Sustainable Development Strategy*[R]. Beijing: Science Press, 1 – 526. (in Chinese)

XU Ji-shen, CHEN Bai-ming, ZHANG Xue-qin, 2001. Ecosystem Productivity Regionalization of China [J]. *Acta Geographica Sinica*, 56(4): 401 – 408. (in Chinese)