Countermeasures for Circular Agricultural Development of Chongqing Based on AHP Approach

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Abstract With rapid economic development, resource and environment problems become more and more prominent. Chongqing Municipality, as a city focusing on industrial development in the past, has serious problem of environmental pollution and scarce agricultural resources. At present, it is urgent to find out how to develop circular agriculture and coordinate economic, social, environmental development. On the basis of understanding the intension of circular agriculture, this paper built evaluation indicator system for development of circular agriculture from social and economic development, resource reduction input, resource recycling use, and resource and environment safety. Then, it made an evaluation of circular agricultural development of Chongqing Municipality by AHP approach combined with gray correlation analysis. Finally, it came up with countermeasures, including reducing input of agricultural production materials, strengthening land management, promoting scientific and technological progress, and improving policy systems.

Key words Chongqing Municipality, Circular agriculture, AHP approach, Countermeasures

1 Introduction

In recent years, the development of circular agriculture has become a hot spot of researches. Chongqing Municipality is a mountain city. Since its resource is limited, traditional economic growth mode has become incapable of solving problems of scarce agricultural resources and inadequate environmental carrying capacity. According to Statistical Yearbook of Chongqing Municipality, the cultivated land of Chongqing in 2013 was 1 462 153.33 hm^2, accounting for 17.76% of total land of Chongqing. The cultivated land per capita was only 0.043 hm^2. At present, the permanent resident population of Chongqing is 29.45 million. Therefore, it has a huge pressure of energy, water resource and ecological environment. There is serious problem of water loss and soil erosion and municipal waste pollution. Since Chongqing focused on industrial development in the past, the emission of "three wastes" is extremely high, including 306.11 million tons of waste water and 835.988 billion m^3 and 50 000 tons of waste gas and solid wastes. These seriously influence agricultural production. In addition, chemical fertilizer and pesticide used in agricultural production exert certain influence on environment and human health. Therefore, it is urgent to transform agricultural development mode, reduce environmental pollution, and realize sustainable development of agriculture. Furthermore, with division of 5 functional zones, Chongqing municipal government attaches great importance to Northeast Chongqing Ecological Conservation Development Zone and Southeast Chongqing Ecological Protection Development Zone. Building a scientific and proper evaluation indicator system for circular agriculture from realities of Chongqing not only can complement researches on circular agriculture, but also can find out problems in the process of circular agricultural development of Chongqing through systematic evaluation, and come up with pertinent recommendations, which are of great significance to regional economic development of Chongqing and coordinated and sustainable development of economy, society and ecology of Chongqing.

2 Connotation of circular agriculture

Circular agriculture originated from circular economy. With agricultural development, there are problems of vulnerable ecological environment and pollution of farmland and water resources. Then, scholars applied the theory of circular economy to agriculture and accordingly introduced the concept of circular agriculture. Through overview of researches of Peng Xiuli (2006), Du Huazhang (2006) and Huo Xiaomei (2010), we found that circular agriculture stresses multiple-level circular use of matter energy of agricultural system and it is required to conduct clean production, reduce input of resources and emission of wastes, and implement closed loop agricultural production. Therefore, the circular agriculture is an agricultural development mode guided by theory of circular economy and thought of sustainable development, using ecological engineering method, taking consumption reduction, reuse and recycling as principle (3R principle), and reaching the objectives of conserving resources and protecting environment through optimizing the structure of entire industrial chain from production to consumption of agricultural products, finally realizing coordination of economic, social and environmental benefits. From this concept, we can see that apart from 3R principle, circular agriculture also features circular design of production process, interdependence of environmental and economic objectives, and low

Received: March 11, 2014 Accepted: April 14, 2014
Supported by Social Science Planning Project of Chongqing (2011YBGL120); National Key Technology Research and Development Program of the Ministry of Science and Technology of China (2012BAD14B18); Ph. D. Foundation Project of Southwest University (swu1209338).
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pollution or even zero emission. Through low input of natural resources, high efficient use and low emission of wastes, it is not only able to increase resource utilization efficiency, reduce environmental pollution, form scientific and modern agricultural production mode, protect rural environment, and improve farmers' living environment, but also able to adjust agricultural industrial structure, transform agricultural development mode, improve quality of agricultural products, and realize sustainable development of agriculture.

3 Establishment of evaluation indicator system for development of circular agriculture

3.1 Principles for establishing the evaluation indicator system.

(1) 3R principle. 3R refers to reduction, reuse and recycling. Design of indicators should follow this principle and reflect reduction and recycling of resources.

(2) Scientific principle. The evaluation indicator system for circular agriculture should fully grasp intension and essence of circular agriculture. Indicators selected should reflect major characteristics and realization degree of circular agriculture. Besides, they should have clear definition and make objective and accurate evaluation of situation of circular agriculture in accordance with actual local situation.

(3) Comprehensive principle. Circular agriculture is a complex and systematic project, so the evaluation indicator system should cover all characteristics of evaluation subject as much as possible, comprehensively reflect factors of evaluation object, and fully consider overall benefits of agriculture, society and environment, to make it comprehensively and systematically reflect operation status of resource utilization and social output in agricultural production activities.

(4) Representative principle. Circular agriculture is a complex ecological economic system. It includes several subsystems. One indicator system hardly covers all aspects of circular agriculture. Thus, it is required to select representative and typical indicator, grasp major aspects of circular agriculture, and avoid simple and repetitive combination of indicators.

(5) Operational principle. The evaluation indicator system for circular agriculture is to be applied in actual evaluation. Thus, design of indicators should be simple and convenient and easy to understand. Evaluation indicators should focus on comparability of time and place, for purpose of comparative analysis. Besides, it should take statistical data as basis, easy to access, analyze and calculate.

(6) Dynamic principle. In short term, the evaluation indicator system for circular agriculture is fixed. However, with the development and change of agricultural system and leading of related local policies, it is necessary to make proper adjustment. Therefore, the selection of evaluation indicators should better describe, depict and measure current development situation and trend of evaluation subjects, to provide indirect information for future forecast and decision-making.

3.2 Framework design of the evaluation indicator system Researches of China's circular agriculture start late. At present, there are few researches about quantitative evaluation of circular agriculture. Typical researches are as follows: Wang Fang, on the basis of development objective of circular agriculture in western region and availability of data, preliminarily established input and output indicators of 1995 – 2004, evaluated relative production efficiency of agricultural resource for agricultural production region by Data Envelopment Analysis (DEA) approach, determined weight of the second level indicator by analytic hierarchy process (AHP) when evaluating development level of circular agriculture in specific region, and determined weight of specific indicators by entropy method, to accurately measure development level and stage of circular agriculture in western region. Hu Yanxia and Li Hong (2009), taking Nanhanji Village marsh gas station and pig farm in Zhoukoudian Town in Fangshan District as research object, made comprehensive evaluation on benefit of ecological economic system for marsh gas fermentation system and their mutual cycle of typical pig farms in Beijing suburbs by energy, emergy and economic evaluation method separately. Huo Xiaomei, Wu Zhiyong and Liu Jiashun (2010) established 4 modules (reduced input of resources, resource recycling use, environmental safety quality and agricultural development level) and 12 indicators of comprehensive evaluation system for circular agricultural development, determined indicator weight by AHP approach, and evaluated development situation by comprehensive evaluation method. Li Juan and Ming Deyan (2010) extracted common factors among 12 driving factors influencing development of circular agriculture with the aid of SPSS software and made comprehensive analysis and research on driving factors and practice model of circular agricultural development of Nanchang City. Zhang Lichao (2011) selected 22 factors in accordance with principle of evaluation indicator system for circular agriculture, converted many indicators into several comprehensive indicators by principal component analysis (PCA) method using dimension reduction thought on the precondition of losing little information, and made analysis on samples by CCR model of DEA approach.

From the above statement, making evaluation on development of circular agriculture only from input and output is limited, while measurement from economy, society and environment is too broad and fails to reflect characteristics of circular agriculture. Therefore, on the basis of researches of these scholars, with reference to merits and demerits, and in combination with development situation of circular agricultural development in Chongqing, we established the evaluation indicator system for development of circular agriculture in Chongqing, with circular agricultural development evaluation indicator system as target hierarchy, and socio-economic development, reduced resource input, resource recycling use, and resource environmental safety as criterion hierarchy, as listed in Table 1.

3.3 Determination of evaluation methods Four major methods are used by scholars in evaluating development of circular ag-

riculture: (i) DEA method; (ii) emergy analysis of input and output; (iii) factor analysis and PCA; (iv) AHP and entropy method. These methods have merits and demerits. Considering data availability and sample size, we adopted qualitative and quantitative combined AHP and gray correlation method to evaluate circular agriculture in Chongqing. Calculation results of weight are listed in Table and the final comprehensive evaluation index of weight multiplied by correlation coefficient is listed in Table 2.

Table 1 Evaluation indicator system for development of circular agriculture

Target hierarchy	Criterion hierarchy	Indicator hierarchy	Weight
Evaluation indicator system for circular agriculture	Socio-economic development	Per capita GDP of agriculture	0.033 0
		Per capita net income of rural residents	0.044 5
		Output value of unit sown area	0.012 6
		Per capita share of grain	0.022 9
		Per capita output value of agricultural labor	0.017 0
		Engel coefficient of rural residents	0.060 0
	Reduced input of resources	Intensity of fertilizer application	0.059 1
		Intensity of pesticide application	0.077 9
		Intensity of agricultural film application	0.044 8
		Intensity of machine use	0.135 7
		Energy consumption index	0.102 8
	Recycling use of resources	Multiple crop index	0.132 5
		Straw utilization rate	0.083 5
		Manure utilization rate	0.052 6
	Resource and environmental safety	Forest coverage	0.059 9
		Effective irrigation coefficient	0.023 8
		Per capita farmland area	0.037 7

Table 2 Comprehensive evaluation index for development of circular agriculture in Chongqing

Year	Comprehensive evaluation index	Socio-economic development evaluation index	Reduced resource input evaluation index	Resource recycling use evaluation index	Resource and environmental safety evaluation index
2000	0.711 4	0.080 7	0.420 3	0.168 7	0.041 7
2001	0.638 6	0.072 8	0.369 6	0.153 2	0.042 9
2002	0.653 3	0.073 8	0.304 8	0.225 3	0.049 4
2003	0.579 4	0.079 0	0.265 8	0.175 0	0.059 5
2004	0.577 6	0.080 6	0.263 1	0.183 9	0.050 0
2005	0.581 2	0.088 1	0.244 4	0.194 3	0.054 3
2006	0.416 2	0.073 6	0.184 3	0.099 6	0.058 6
2007	0.414 4	0.081 2	0.175 7	0.095 9	0.061 6
2008	0.439 5	0.090 6	0.167 5	0.108 9	0.072 5
2009	0.452 8	0.102 1	0.157 2	0.116 7	0.076 9
2010	0.475 9	0.114 0	0.154 9	0.120 8	0.086 2
2011	0.510 0	0.137 5	0.153 3	0.122 0	0.097 1
2012	0.594 1	0.182 5	0.163 2	0.126 9	0.121 4

4 Comprehensive evaluation of development of circular agriculture in Chongqing

4.1 Overall development trend According to comprehensive evaluation index, it is able to obtain overall trend curve (as shown in Fig. 1) for agricultural development of Chongqing in 2000 – 2012.

From the above curve, we can see that the overall development of circular agriculture in Chongqing takes on rising trend. In 2007, the overall score was the lowest at 0.4144; in 2000, it reached 0.7114. Thus, the overall development can be generally divided into two stages.

(1) The first stage is 2000 – 2006: at this stage, agriculture of Chongqing was in the period of transition from traditional extensive growth mode to circular agriculture; the circular agriculture is still at exploration stage; the awareness of reduced resource input and recycling use is low; the pursuit of rapid economic growth results in high energy consumption; in addition to negative influence of industrialization and urbanization, the environmental pollution is serious, so this stage takes on overall decline trend.

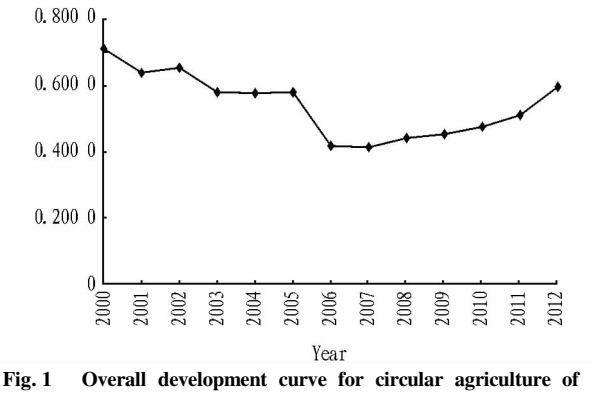

Fig. 1 Overall development curve for circular agriculture of Chongqing in 2000 – 2012

(2) The second stage is 2007 – 2012: this stage takes on gradual rising trend mainly because the understanding of circular

economy is deep; both central to local government increasingly attached great importance to circular agriculture. Chongqing Municipal government formulated the *Eleventh Five – Year Plan for Development of Circular Economy in Chongqing Municipality*, stating that it is required to energetically develop circular agriculture, promote planting industry to provide feed for breeding industry, and the breeding industry can provide fertilizer for planting industry, and planting and breeding industries can provide raw materials for processing industries, so as to realize coordinated development of agriculture, forestry, animal husbandry, and fishery. The concept of ecological leisure agriculture and green agriculture is gradually permeated into agricultural production and farmers' life, such as pig – marsh gas model in rural area. They set up vertical farming model, pond – lotus planting – fishing model, rape flower sightseeing site, and grape picking garden. These models are seen everywhere in rural areas of Chongqing. In this situation, agricultural resources are effectively utilized, environmental destruction is effectively contained, and the development level of circular agriculture is rising.

4.2 Classification indicators As shown in Fig. 2, in the process of development of circular agriculture in Chongqing:

(1) Reduced resource input takes on gradual reduction trend. The index dropped from 0.420 3 in 2000 to 0.163 2 in 2012, showing high agricultural energy consumption. According to the *Statistical Yearbook of Chongqing Municipality*, in 2000 – 2012, the fertilizer application rose from 720 000 tons to 960 200 tons, pesticide application rose from 18 500 tons to 19 500 tons, agricultural film application rose from 19 600 tons to 40 900 tons, total power of agricultural machinery rose from 5 864 700 kW to 11 620 000 kW, and rural power consumption rose from 2 787 280 000 kWh to 7 380 000 000 kWh.

(2) Recycling use of resources takes on rising trend. This should mainly give the credit to deeper understanding of circular economy. With increasing of awareness for circular economy, people start to return straws to field and generate marsh gas by manure. The farmland utilization degree is higher and higher, recycling use of wastes reduces discharge of wastes, and it has made great achievement.

(3) Socio-economic development takes on rising trend, increasing from 0.080 7 in 2000 to 0.182 5 in 2012. This is mainly benefited from rapid economic development: per capita net income of rural resident household reached 5 859.3 yuan in 2012, which was 4 times in 2000, 9.4% lower than in 2000; from 2000 to 2012, per capita agricultural GDP rose from 1 333.76 yuan to 6 644.69 yuan; the output value of unit sown area rose from 8 824.45 yuan/hectare to 37 254.67 yuan/hectare; grain yield per unit area rose from 4.08 tons to 5.04 tons; per capita output value of agricultural labor rose from 2 657.53 yuan to 14 205.58 yuan, and technical skill of labors is improved.

(4) Resource and environmental safety also takes on gradual rising trend, with index increasing from 0.041 7 in 2000 to 0.121 4 in 2012. This is mainly benefited from increase of people's awareness for environmental protection. The emission of "three wastes" was reduced and farmland was protected. In 2000 – 2012, the forest coverage, effective irrigation coefficient, and per capita farmland area rose from 23.10%, 39.54%, and 0.09 hectare/person to 42.10%, 48.08% and 0.12% hectare/person respectively.

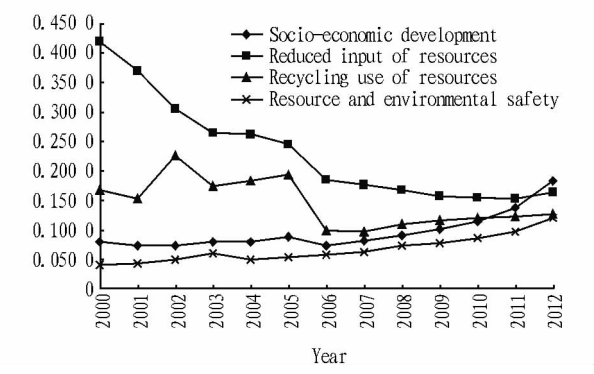

Fig. 2 Classification curve for development of circular agriculture of Chongqing in 2000 – 2012

4.3 Achievements and problems (1) Achievements: since 2000, agricultural development level of Chongqing was significantly improved. The curve of social and economic development and increase in per capita agricultural GDP and per capita net income of farmers fully demonstrate this. Resource and environmental safety was protected and takes on rising trend, indicating that people's awareness for environmental protection is strengthened, recycling use of resources is valued, and emission of wastes is reduced.

(2) Existing problems: low agricultural scientific and technological level; agricultural development mainly relies on consumption of resources, leading to decline trend in reduced input of resources, extensive application of chemical fertilizer and pesticide, but the utilization efficiency is not high. Besides, the farmland resource is scarce. With influence of comparative benefit of industrialization, some counties run after only benefits, leading to occupation of much farmland. In 2013, the farmland area of Chongqing only accounted for 17.76% of its total land area, and the per capita farmland area was only 0.65 mu, lower than the 0.8 mu red line set by FAO. The per capita grain share also decreased year by year, from annual 0.37 ton per capita in 2000 to 0.34 ton per capita in 2012. Therefore, it is required to improve technical level and quality of labors, raise resource utilization efficiency, and reduce agricultural energy consumption and environmental pollution.

5 Countermeasures and recommendations for development of circular agriculture in Chongqing

In line with existing problems in development of circular agriculture in Chongqing, it is recommended to explore characteristic agricultural modernization path, energetically develop high profitable agriculture, promote agricultural technological progress, reduce

resource input, ensure grain safety, and promote increase of farmers' income on the basis of local characteristics, resource endowment, development foundation, functional orientation, and comparative advantages.

From industrial distribution of 5 functional zones, it can be seen that in 2012, the proportion of primary, secondary, and tertiary industries was 8.2:52.4:39.4, in the urban function core zone, the proportion was 0.7:42.7:56.6, showing high proportion of the tertiary industry, which is consistent with developing high end service industry in the plan; in the urban function extension zone, the proportion was 4.4:62.4:33.1; in the new urban development zone, the proportion was 11.8:58.6:29.6, in these two zones, the proportion of secondary industry was higher than 50%, which is basically consistent with the plan of raising urbanization level; in the northeast Chongqing ecological conservation zone, the proportion was 14.9:49.3:35.8, in the southeast Chongqing ecological protection zone, the proportion was 16.0:48.6:35.3, the proportion of secondary industry was much higher than the primary industry, which has a large gap with the plan. On the whole, the proportion of agriculture in northeast and southeast Chongqing zones is the highest among 5 functional zones. Therefore, the development of circular agriculture should focus on northeast Chongqing ecological conservation zone and southeast Chongqing ecological protection zone, attach importance to development of characteristic profitable agriculture, and properly treat the relationship between agricultural development and ecological and environmental protection. Specifically, following measures should be taken.

5.1 Reducing input of agricultural production materials and increasing utilization efficiency of agricultural resources It is recommended to put an end to the serious energy consumption, excessive application of chemical fertilizer and pesticide in the development of circular agriculture in Chongqing. On the one hand, competent authorities should energetically popularize technology of testing soil for formulated fertilization, guide farmers to apply farm manure, return straws to fields, increase organic matter of farmland, and reduce application of chemical fertilizer. On the other hand, they should extend technology of proper pesticide application, provide training for farmers in safe use of pesticide, guide farmers to use high-effective and low-residue pesticide, forbid excessive use of pesticide and high toxic pesticide, and widely carry out comprehensive prevention and control of plant diseases and insect pests.

5.2 Strengthening land management and increasing farmland utilization efficiency It is proposed to strengthen land management and increase farmland utilization efficiency, to ensure grain safety under the guidance of Scientific Outlook on Development and concept of sustainable development. Firstly, it should enhance farmland protection, implement strict farmland protection system, strictly prohibit occupation of agricultural land, and avoid ineffective input and waste of farmland as much as possible. Secondly, farmland development should be strengthened, to take full advantage of waste mountains and slope land, actively introduce and develop excellent crop varieties suitable for barren land or adverse environment, speed up transformation of medium and low yield field, and increase farmland fertility. Thirdly, it should take full advantage of mountain characteristics of Chongqing, rely on garden facilities, use advanced variety technology, cultivation technology, and vertical development technology, establish a multi-level and multi-series industrial structure, and implement relay cropping to take full advantage of farmland resources.

5.3 Promoting agricultural sci-tech progress and attaching importance to personnel training Science and technology are foundation and motive force for development of circular agriculture. Thus, it is recommended to set up technological support system for circular agriculture. Firstly, it is required to improve agricultural sci-tech development system, strengthen basic research of agricultural science, focus on low-pollution agricultural production technology, renewable resource recycling technology and green manufacturing technology, and establish comprehensive system integrating agriculture, forestry, animal husbandry, sideline production and fishery favorable for ecological balance. Secondly, it should enhance technological exchange of circular agriculture, set up agricultural production technological exchange platform through organizing sci-tech achievement consulting meetings and sci-tech trading activities, actively introduce domestic and foreign advanced agricultural technologies, strengthen cooperation with universities, colleges and scientific research institutions, found key laboratory, and establish technological innovation system for circular agriculture. Besides, it should enhance training of farmers, to make more farmers become technical experts and core force in agricultural development, and establish agricultural technological talent team.

5.4 Establishing green agricultural accounting system and enhancing incentive and constraint functions of policies In the process of development of circular agriculture, both farmers and enterprises will come across obstacles of funds and technologies, thus government should provide corresponding policy system as support and guarantee. Firstly, it should set up green agricultural counting system, reflecting economic benefits and level of agricultural pollution and resource cost. Secondly, government should bring into play incentive and restraint functions of policies, provide financial support for enterprises and farmers of circular agriculture, green agriculture, ecological agriculture, and enhance construction of infrastructure and auxiliary facilities. For enterprises with high technological content and low environmental pollution, it is recommended to provide preferential policies in investment and financing and provide corresponding financial subsidy. For enterprises adopting renewable resources, clean production, recycling use, and comprehensive control, government should reduce or exempt certain taxes to encourage more enterprises to participate in production of circular agriculture. In addition, fore those enterprises with high agricultural pollution, it is required to enlarge scope of taxes, to control high consumption and high pol-

lution and protect ecological environment.

References

[1] PENG XL. Considerations on the countermeasures of developing Hu'nan circular agriculture[J]. Journal of Hunan Economic Management College, 2006, 17(5): 16-18. (in Chinese).

[2] DU HZ, MIAO RR, YAN GZ. Studies on measures of constructing recycle agriculture[J]. Management of Agricultural Science and Technology, 2006, 25(5): 18-20. (in Chinese).

[3] HUO XM, WU ZY, LIU JS. Research on the development of circular agriculture in Hebei Province[J]. Journal of Hebei Polytechnic University: Social Science Edition, 2010, 10(6): 68-70. (in Chinese).

[4] ZHANG LC. Research progress of evaluation system for China circular agriculture development[D]. Shenyang Agricultural University, 2011. (in Chinese).

[5] QIN HS. Considerations on Gansu circular agricultural development pattern [J]. Economic & Trade Update, 2012(6): 125-126. (in Chinese).

[6] YANG J, LIU JS. Working functions of the development of circular agriculture[J]. Journal of Anhui Agricultural Sciences, 2006, 34(18): 4791-4792. (in Chinese).

[7] XIAO WX. Exploration on developing agricultural recycling economy[J]. China Business Magazine, 2010(6): 168-170. (in Chinese).

[8] TIAN H, CHEN J, WANG L. Countermeasures of building saving recycling agriculture——Taking Henan Province as example[J]. Journal of Henan Agricultural Sciences, 2011, 40(11): 4-7. (in Chinese).

[9] YU WW. The practice of structural adjustment of Holland circular agriculture and its experience reference[J]. China Economist, 2012, 7(3): 83-84. (in Chinese).

[10] QIN YJ, HU BQ, TANG CT. County agricultural development evaluation and empirical study based on the circular economy concept[J]. Guangdong Agricultural Sciences, 2011(19): 195-198. (in Chinese).

[11] HU YX, LI H, WANG Y, *et al*. Comprehensive evaluation on the multi-output cycling agriculture in Beijing Suburb——A case study of the big hoggery-biogas eco-economy system in Fangshan District[J]. Chinese Agricultural Science Bulletin, 2009, 25(09): 251-257. (in Chinese).

[12] ZHAI XJ. Study on Chinese agricultural recycling economy development mechanism[D]. Northeast Forestry University, 2011. (in Chinese).

[13] MA X. Research on development strategies of agricultural recycling economy: Case studies on Gushi County in Henan Province[J]. Ecological Economy, 2012(4): 141-142. (in Chinese).

[14] GAO LY. Study on recycling economy development model—Also discussion on Yunnan circular agriculture[J]. Modern Economic Information, 2011(19)274-275. (in Chinese).

[15] CAI FY, SUN B. The research on agriculture development in metropolis circle——A case of Ji Nan Metropolis Circle[J]. Economic Review, 2010 (4): 60-61. (in Chinese).

[16] LI J, MING DY. Driven factors analysis of developing circular agriculture [J]. Journal of Anhui Agricultural Sciences, 2010, 38(9): 4854-4855. (in Chinese).

[17] LUO L. Research on evaluation of agriculture circular economy in Xinjiang [J]. Ecological Economy, 2010(2): 156-158. (in Chinese).

[18] QIN HS. On circular agriculture development problems from the viewpoint of new socialist countryside[J]. Journal of Hubei College of Finance and Economics, 2012, 24(3): 27-29. (in Chinese).

[19] WU SH. Research on the construction of regional agriculture circular economy system [J]. Agricultural Economy, 2013(4): 24-25. (in Chinese).

[20] WANG QD. Connotation and development of circular agriculture economic system[J]. Agricultural Economy, 2013(2): 72-73. (in Chinese).

[21] Chongqing Statistical Yearbook. Chongqing statistical information network -http://www.cqtj.gov.cn/tjnj/2013/indexch.htm. (in Chinese).

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[3] YI JH, ZENG ZY, HAO GQ, *et al*. Comparative study on nutritive value of *Tilapia nilotica* and *Hypophthalmichthys molitrix*[J]. Chinese Journal of Zoology, 1983(3): 43-44. (in Chinese).

[4] Famous and popular of Guangxi tilapia in Europe and America markets[J]. Journal of Aquaculture, 2006, 27(6): 15. (in Chinese).

[5] GAN X. The advantages, chances and measures of tilapia industry in Guangxi[J]. Fisheries Science & Technology of Guangxi, 2004(4): 11-13. (in Chinese).

[6] SHAN HY, HAN J, YANG H. Analysis on tilapia production and trade status, 2011[J]. China Fisheries, 2012(5): 38-40. (in Chinese).

[7] LEI GY, CAO JM, WAN Z, *et al*. Analysis on the development status of *Tilapia mossambica*, 2008[J]. Guangdong Agricultural Sciences, 2009(7): 240-243. (in Chinese).

[8] WEI XS, LIN Y, YANG HZ, *et al*. Prevalence and control of pathogenic streptococcus from tilapia in Guangxi[J]. Guangxi Journal of Animal Husbandry & Veterinary Medicine, 2013, 29(1): 57-60. (in Chinese).

[9] MING JC, YUAN XH, YUAN YM. The status quo, problems and countermeasures of the development of Guangxi tilapia industrial chain[J]. China Fisheries, 2012(12): 20-23. (in Chinese).

[10] WU RX, WU T. Research progress of earthy taste of freshwater fish and the deodorization of fishy odor[J]. Journal of Yangtze University (Nat. Sci. Edit.), 2011, 8(10): 253-256. (in Chinese).

[11] WANG W, DING JY, FANG JC. The current situation and analysis of the standardization of tilapia industry[J]. Journal of Shanghai Fisheries University, 2012, 21(6): 976-981. (in Chinese).

[12] Guangxi tilapia safety management system occupies the national leading level[J]. China Journal of Animal Quarantine, 2012, 29(9): 79. (in Chinese).

[13] ZHU HP, LU MX, HUANG ZH, *et al*. The status quo of *Tilapia mossambica* process, the advantages of industrialization development and measures for improving competitiveness of export[J]. Fisheries Science & Technology, 2009(5): 11-14. (in Chinese).

[14] WANG B, LI XZ. Analysis on the advantages of *Tilapia mossambica* export and the trade structure coupling[J]. World Agriculture, 2010(2): 34-37. (in Chinese).

[15] ZHANG YH, WANG JH. Analysis on the influencing factors of international market competitiveness of China's Tilapia mossambica[J]. World Agriculture, 2012(7): 96-100. (in Chinese).