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Development of Agricultural Recycle Economy in Arid Areas of Hexi Corridor

——A Case Study of Zhangye City, China

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Abstract Taking Zhangye City as an example, the thesis analyzes the restricted factors of resources and environment confronted by the agriculture in arid area of Hexi Corridor: the first is the agricultural natural resources. The area of cultivated land decreases year by year, and there are sharp decrease of biological diversity as well as the shortage and waste of water resources; the second is the ecological environment. There are critical soil erosion, frequent natural disaster and outstanding agricultural area source pollution; the third is the rural economy. The agricultural structure still can not meet the need of agricultural development in recent years, and the proportion of agricultural product processing is low. It points out that implementation of agricultural recycle economy is the necessary choice of the agricultural development in Zhangye City. Developing recycle economy is conducive to improving ecological environment and realizing agricultural sustainable development; developing recycle economy can solve the agricultural area source pollution to much extent and protect rural environment; developing recycle economy is conducive to adjusting rural industrial structure, increasing job opportunities and increasing farmers' income; developing recycle economy is conducive to elevating the international competitiveness of agricultural products. The thesis also has put forward the countermeasures of developing agricultural recycle economy in Zhangye City as follows: firstly, fostering the ambience of the development of agricultural recycle economy; secondly, forming the incentive mechanism of development of agricultural recycle economy; thirdly, broadening the investment channel of development of agricultural recycle economy; fourthly, perfecting socialized service system of agricultural recycle economy.

Key words Zhangye City, Restriction of resources and environment, Agricultural recycle economy, Countermeasures, China

Based on the law of ecology and the principle of reduction, reuse and resources, the agricultural recycle economy focuses on the high efficiency recycling use and ecological environment protection, and is characterized by low consumption, low emission and high efficiency. It is an agricultural developing model of building resources-saving, environment-friendly agriculture, and realizing the concept of agricultural sustainable development[1]. It transforms the economic activities from the single linear process of resources-products-wastes to the closed chain material flow model of resources-products-resources anew[2]. Developing agricultural recycle economy is significant in reality to rural overall planning, rural comprehensive development, realization of recycling of material in system, benign recycling of ecology and economy, and unification of economy, environment and social benefit[3]. Zhangye City, in the central Hexi Corridor, is important base of cash grain and base of thoroughbred breeding in China. Along with the quick developmental economy of Zhangye City and the increasing pressure of resources and environment, if the agricultural production adopts traditional production model and management methods in the future economic development, the contradiction of production and environment will become more and more acute, and the restriction role of ecological environment on agricultural development will become more and more outstanding, which impedes the realization of stability and continuity of agricultural production. Hence, changing agricultural developmental model is urgent.

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1 The restriction of resources and environment faced by the agricultural development in Zhangye City

1.1 The problems of agricultural natural resources

1.1.1 The area of cultivated land decreases year by year. Along with the economic development in Zhangye City, increasing expansion of the construction scale of city and village and increasing construction land year by year, the area of cultivated land tends to decrease by degrees. According to statistics, the area of cultivated land in Zhangye City decreased from 0.191 million hm^2 in the year 2000 to 0.192 million hm^2 in the year 2009. The area of cultivated land decreased by 1 185.5 hm^2 in the aggregate and decreased by 119.9 hm^2 annually.

1.1.2 The biological diversity decreases sharply. There is serious deforestation and opening up wasteland in Zhangye City and more than 90 percent new added cultivated land arises from the damage on the forest and meadow. Due to the irreversibility of extinction of species, the decreased biological diversity and the extinction of myriad species will destroy the recycling chain of material flow and energy flow in whole ecological system, and exert critical impact on other species.

1.1.3 There are shortage and waste of water resources. In terms of water resources, Zhangye City is a city devoid of water resources badly. The average precipitation of many years is merely 680.9 mm and the average total amount of water resources of many years is 30.8 billion m^3 with 358 m^3 per capita, greatly smaller than the international accepted critical value of 1 000 m^3. Currently, the per capita amount of land resources and water resources in Zhangye City is just 14.7 percent and

15.7 percent of the national average respectively. In addition to the great difficulty of water use in some areas and the phenomenon of water resources waste such as border method of irrigation and flooding irrigation, some places still adopt the way of flooding irrigation so as to make the cultivated land get not effective irrigation, leading to the serious water resources waste. Recently, the water use coefficient of agricultural irrigation in Zhangye City is about 0.43, and there is a great gap in comparison with the developed countries in the world. For example, America reaches more than 0.70, and Israel reaches even 0.90. According to the current developing model, it is expected in the year 2012 that the demand of water resource in Zhangye City will reach 2.914 billion m^3, 1.4 times the total amount of the current water resources. There is urgent need of water resources, which can not guarantee the need of water resources during agricultural development. The information of land irrigation in Zhangye City from 2000 to 2008 can be seen in the Table 1[4].

Table 1 Land irrigation conditions of Zhangye during the recent years

Year	Farmland area $\times 10^4$ hm^2	Effective irrigation area $\times 10^4$ hm^2	Irrigation rate//%	Guaranteed irrigation area $\times 10^4$ hm^2	Guaranteed rate of irrigation %
2000	18.72	14.54	77.69	–	–
2001	18.79	15.06	80.15	–	–
2002	18.71	15.09	80.66	13.42	71.73
2003	18.80	14.86	79.07	13.35	71.03
2004	18.58	14.84	79.88	13.36	71.91
2005	19.10	15.15	79.32	13.67	71.57
2006	19.11	14.86	77.74	13.51	70.70
2007	19.13	15.23	79.62	13.89	72.59
2008	19.22	15.22	79.18	13.89	72.27

1.2 The problems of ecological environment Zhangye City is in the hinterland of Eurasia with fragile ecological environment. There are shortcomings in the regional combination of water, heat and soil. Since the reform and opening up, under the traditional model of economic growth, industrialization, agricultural modernization and urbanization make people consume natural resources greatly. The tendency of deterioration of ecological environment is not inhibited effectively.

1.2.1 The soil erosion is serious. Zhangye City is the ecological zone of arid dessert in inner land with scarce precipitation and great evaporation. The distribution of precipitation is not even in time and space. In terms of time, the precipitation mainly concentrates in June, July and August. In terms of space, because precipitation mainly concentrates in areas around Qianlian Mount, and the precipitation in low mountainous areas and areas of Corridor is scarce, so the vegetation is sparse, which causes wind erosion. Especially in spring, autumn and winter when there is frequent wind, due to scarce precipitation, small coverage rate of vegetation and serious wind erosion, in addition to the shortage of water resources, in the entire area, there are approximately 0.033 million hm^2 farmlands that suffer drought in the period of irrigation; the area of windbreak and sand fixation forests, and water sources conservation forests decreases due to drought and falling of subterranean water level; the grassland increasingly degenerates due to shortage of water, and some plants in desert die in succession, which make the desertification become more and more serious. For the time being, there are 6 million hm^2 desert and gobi in the entire region and some regions are threatened by quicksand. The area of sandstorm damage reaches 0.003 million hm^2, the area of desertificated farmland reaches 0.017 million hm^2 and more than 60 percent of grassland in whole region is desert or semi-desert grassland.

1.2.2 The natural disaster is frequent. The deterioration of ecological environment causes frequent natural disaster and increasingly serious damage. The soil erosion influences the water conservation ability of soil, leading to frequent drought. The scarce precipitation and continuous sizzling days cause infestation of forest pests. In 1996, there was epidemic situation in Gaotai County firstly. Henceforth, there were 11 epidemic situations in Zhangye and Shandan with 3 300 hm^2 damaged forests. In order to preclude the spread of pest damage, plenty of damaged trees were chopped and burnt promptly, intensifying soil erosion.

1.2.3 The pollution of agricultural area sources becomes more and more outstanding. According to the estimation of environment protection departments, the pollution of agricultural area sources becomes the third pollution source after industrial and life sewage. The proportion of water sources pollution generally reaches 1/3, and reaches more than 50 percent in the serious regions. The agricultural area sources pollution is the agricultural environmental pollution in essence, which can be embodied in 4 aspects.

1.2.3.1 The agricultural pesticide and fertilizer are used greatly with low efficiency. According to the statistics of agricultural departments (Table 2)[4], the use amount of agricultural fertilizer and pesticide in Zhangye City tends to increase year by year. There is a phenomenon of abuse and overuse. The use proportion of chemical pesticide in pesticides is small and organic phosphor is still the main ingredient. Zhangye City uses 0.27 million tons fertilizer annually, while the practical use rate of fertilizer is just 40 percent, and the use rate of nitrogenous fertilizer is just 30 percent. In addition, the pesticide spraying technology is outdated and most are sprayers carrying on back, which reduces the use rate of agricultural pesticide, increases cost of spraying, and pollutes agricultural products and ambience.

1.2.3.2 The pollution of large-scale breeding of livestock and poultry becomes serious. In the recent years, the large-scale breeding bases of livestock and poultry increases incessantly in Zhangye City. And the amount of large-scale livestock and poultry breeding increases incessantly, leading to more excrement and sewage. But most breeding bases have not disposal facility of excrement and sewage, so the pollution exceeds environmental capacity and exerts a serious impact on environment.

1.2.3.3 The use rate of stalks resources is low. Along with the increasing output of agricultural crop and the multiple crop index, the output of stalks in Zhanye City is also increasing. According to estimation, for the nonce, there are 1.6 million

tons stalks left annually in Zhangye City, but the use rate is just 0.5. Traditionally, the stalks are used as life energy, fertilizer, fodder and so on, but due to improvement of farmers' life level in recent years, the famers in many regions no longer put the stalks as the main energy for cooking and warming. The quickened pace of agricultural mechanization makes the quantity of farmers' draught animals decrease quickly, and the use amount of stalk fodder decreases prominently. Meanwhile, the traditional way of storing compost and so on decrease along with the increased use amount of fertilizer, hence the arbitrary littering and burning of agricultural crop stalks not only waste energy immensely, but also cause environmental pollution. According to estimation, if 0.58 million tons stalks left annually in Zhanye City are silaged, it can breed 0.5 million milk cows, yielding 1.25 million tons milk and obtaining total income of 2.5 billion yuan. If the stalks are used to cultivating mushroom, it can yield 0.75 million tons mushroom annually and the gross income can reach 1.5 billion yuan.

Table 2 Application amount of fertilizer, pesticides and plastic film in Zhangye during the recent years

Year	Farmland area $\times 10^4$ hm^2	Total fertilization amount//t	Average fertilization amount kg/hm^2	Total application amount of pesticides //t	Average application amount of fertilizer kg/hm^2	Total application amount of plastic film t	Average application amount of plastic film kg/hm^2
1995	18.56	163 869.72	8.829 2	399.26	0.021 5	618.55	0.033 3
1998	18.72	241 893.41	12.921 7	546.57	0.029 2	2 444.86	0.130 6
2000	18.79	246 004.01	13.092 3	–	–	3 659.95	0.194 8
2002	18.71	247 917.61	13.250 5	806.60	0.043 1	5 353.89	0.286 2
2004	18.80	263 358.10	14.008 4	1 010.80	0.053 8	5 767.75	0.306 8
2005	18.58	268 966.98	14.476 2	1 085.85	0.058 4	7 646.79	0.411 6
2006	19.10	270 290.97	14.151 4	1 094.85	0.057 3	7 825.16	0.409 7
2007	19.11	277 779.35	14.535 8	1 429.35	0.074 8	7 599.49	0.397 7
2008	19.13	274 416.93	14.344 8	1 483.35	0.077 5	7 486.53	0.391 4
2009	19.22	274 710.38	14.292 9	1 487.63	0.077 4	7 849.60	0.408 4

1.2.3.4 There is increasing great latent threat of agricultural mulch film pollution. According to the survey of related departments, the coverage area of mulch film in Zhangye City is large with about 0.01 million tons use amount of mulch film. The coverage area of mulch film in Zhangye City is very big, but there is more than 60 percent residual soil. The plastic film is high molecular compound, and the natural degradation cycle is 200 to 300 years. When the residual film in a acre of farmland reaches 2.4 kilogram, the output of wheat will decrease by 7 percent and the output of corn will decrease by 8 percent. The deteriorated agricultural environmental quality will inflict negative impact on agricultural production in the long run, and hamper the production of organic agricultural products, non-pollution agricultural products and green agricultural products.

1.3 The problems of rural economy

1.3.1 The agricultural structure still can not meet the need of agricultural development in new stage. In terms of agricultural industrial structure, along with the elevated level of agricultural modernization, the proportion of the output value of primary industry in GNP decreases year by year, but the status of the primary industry is still outstanding. In the year 2007, the proportion of the structure of three industries changed to 37:29:34 from 30:36:34 in the year 2002, and the primary industry decreased by 7 percentage points. But in comparison with the proportion of 14.6:46.1:3.9 of whole province, 11.7:48.9:39 of whole nation, the proportion of the primary industry rises by 15.4 percentage points and 12.9 percentage points in comparison with that of whole province and whole nation respectively. Generally, in the agricultural industrial structure, the proportion of planting is big, which cannot meet the need of agricultural commercialization, specialization and modernization.

1.3.2 The proportion of agricultural products processing is small and the processing is not deep. Recently, the rural economy develops rapidly in Zhangye City, but the processing industry of agricultural products develops slowly and the value of agricultural products increases with a small margin. The processing degree of agricultural byproducts is low, most are initial processing and there are limited varieties of processing. For the time being, the ratio of the output value of processing industry which takes the agricultural products as material and agricultural output value is 0.37:1, just 43.5 percent of the national average, 10 percent of that of the developed countries, and the processing degree of byproducts is merely 20 percent.

2 Implementation of agricultural recycle economy is the necessary choice of agricultural development of Zhangye City

2.1 It is beneficial to improving ecological environment and realizing agricultural sustainable development Zhangye City is the typical arid and semi-arid region, which mainly specializes in agricultural development. The ecological environment in the region is very fragile, and the water resources restrict agricultural development prominently. In addition, the development and use rate of water resources (the ratio of water provision amount and the total amount of water resources) in the region is 92 percent, while that of the nation is 20 percent and that of the northwestern regions is 53.3 percent. The irrational use of water resources causes land desertification, soil salinization and deteriorated ecological environment. In addition to the overuse of agricultural pesticide and fertilizer during agricultural production in Zhangye City, the agricultural ecological

environment deteriorates day by day and the ecological environment is damaged critically. The reality has not allowed Zhangye City to obtain rapid agricultural economic development at the cost of overusing resources and sacrificing environmental benefit. It is necessary to transform the model of economic growth to develop agricultural recycle economy, so as to conduce to improving ecological environment and realizing agricultural sustainable development[5].

2.2 It can solve agricultural area pollution to much extent and protect rural environment Developing agricultural recycle economy can protect rural ecological environment, effectively use agricultural resources, propel socialist new village construction and realize the goal of making the appearance of villages clean. On one hand, by clean production and recycling use of agricultural resources, we can effectively reduce the emission of wastes during agricultural production, and alleviate the negative impact on agricultural ecological environment. On the other hand, during the development of agricultural recycle economy, due to conforming to ecological law, the decrease of use amount of fertilizer and agricultural pesticide can promote the quality of products, and eradicate the pollution of agricultural products.

2.3 It is beneficial to adjusting rural industrial structure, increasing job opportunities and increasing farmers' income The agricultural recycle economy is a technological economic model of sustainable development in essence. Under this economic model, we can obtain maximum output and profit by recycling use of natural resources. By virtue of material recycle and energy transformation of whole agricultural system, recycle of wastes, the principle of mutual generation and constraining among organism, and reduction of wastes emission, we can effectively promote use rate of resources, decrease production cost and promote agricultural economic benefit[6]. Meanwhile, developing intensive management during development of agricultural recycle economy, comprehensive use and development of resources, preventing pollution, and adopting high technology and applied technology to transform traditional industry can extend industrial chain, create more job opportunities in rural areas for farmers, and promote the efficiency of rural labor forces. Consequently, in terms of the socio-economic development in Zhangye City for the time being, developing agricultural recycle economy is necessary.

2.4 It is beneficial to promoting international competitiveness of agricultural products As China joins WTO, the agricultural products in China are confronted by the dual challenges of influx of multitudinous agricultural products from abroad and participation in the global competition. In the meantime, in order to maintain the national interest, many countries erect green barrier, and requirements of agricultural products become much stricter. They not only require the final products to comply with standard, but also make every chain of the production comply with the need of environmental protection, which poses severe challenge to the export and processing of China's agricultural products. While implementing agricultural recycle economy, and practicing clean production and ecological agriculture, are beneficial to promoting quality and safety of agricultural products of Zhangye City, breaking green barrier and strengthening the competitiveness of agricultural products of Zhangye City in international market.

3 The countermeasures of developing agricultural recycle economy in Zhangye City

The construction of agricultural recycle economy is a comprehensive systematic project, involving environment, economy and society. Developing agricultural recycle economy not only needs the extensive participation of farmers and enterprises, but also needs the support and cooperation of the relevant governmental departments. It is necessary to innovate upon thought concept, operating mechanism, policy and technology, so as to create good fundamental conditions and policy environment.

3.1 Foster social ambience of agricultural recycle economy In the process of developing agricultural recycle economy, we should adopt feasible measures, reinforce publicity and guidance, and create the social ambience beneficial to agricultural recycle economic development. Firstly, by virtue of the modern media such as newspaper, broadcast and television, and holding training class of agricultural recycle economy, we can intensify the publicity and education on the multitude, especially the farmers, in order to make them know the related knowledge of agricultural recycle economy; secondly, we should conduct the education of ecological consuming concept and green conception on consumers, make consumers recognize the organic food and green food better, advocate green consumption, and pay attention to the disposal of rubbish in the process of consumption in order to prevent environmental pollution.

3.2 Form the incentive mechanism of agricultural recycle economic development The agricultural recycle economy has the externality that can not be ignored. So, firstly the government should make full use of the economic lever such as industry, revenue, price and investment, in order to offer support for the development of agricultural recycle economy. It can tax the relevant means of agricultural production such as the overused fertilizer and agricultural pesticide, and also can subsidize the farmers who develop methane project, and return tax for the processing enterprises which produce clean and energy-saving agricultural products; secondly, we can practise the oriented investment policy, and the government at all levels can play the role of guiding social investment so as to guild the financial sectors to offer loan support for the energy-saving and comprehensive-use program; finally, considering the cost of producer and consumer as well as profit, by means of the market mechanism, we can change the formers economic stimulation model of producers and consumers, and guide their behavior in order to propel the development of agricultural recycle economy voluntarily and realize the win-win of socio-economic benefit and environmental benefit.

3.3 Broaden the investment channel of agricultural recycle economic development In the process of developing agricultural recycle economy, it is necessary to reinforce the input degree of capital, determine capital sources and broaden finan-

cing channel. Firstly, we can subsidize the agricultural recycle economy directly to bridge the gap of development capital; secondly, we can establish perfect financing channel to solve the problem of capital shortage. For example, we can finance in the form of fund, or directly absorb folk capital, or promote rural financial system reform vigorously, expand the scale of rural soft loan and intensify the financial investment in agriculture; thirdly, by means of the combination of agriculture and other introduced industries, for example, developing ecological tourism and use the tourism profit to protect ecological environment, we can promote the development of agricultural recycle economy on a certain basis and level; fourthly, we can actively encourage rural collective and farmers to invest. The investment has a irreplaceable role in developing agricultural recycle economy, so we should give full play to the enthusiasm and initiative of rural collective and farmers so as to exert their role in the extreme.

3.4 Intensify the technological support for agricultural recycle economy The agricultural technological innovation can guarantee the agricultural development and promote agricultural recycle economic development. Firstly, we should make full use of various kinds of agricultural resources of science and research, intensify the cooperation with science and research institution, colleges and leading enterprises and elevate the contribution ability of agricultural technology; secondly, we should develop biological project technology, cultivate the new varieties of plants and animals with high yielding, high quality and antidisease and antipest, and research biological agricultural pesticide and biological manure; thirdly, we should develop high yielding and high efficiency three-dimensional growing technology, symbiotic reciprocal breeding technology, fertilizing technology, rural household methane technology and the technology of rural energy development and recycling use; fourthly, we should reinforce the research on high technology such as the impact of genetically modified technology and information technology on agricultural ecological system, in order to form the technological support system beneficial to sustainable development.

3.5 Perfect the socialized service system of agricultural recycle economy We should establish and perfect the socialized service system of agricultural recycle economy, especially establish the service network structure of agricultural recycle economy in the every chain of production. On one hand, the government should reinforce the degree of working, and transform the socialized service system of agricultural recycle economy into the unified system of county-town-village-farmer according to the need of agricultural recycle economic development, in order to make the agricultural recycle economy have complete planning, industrial choosing guidance and the analysis and prediction service of industrial result before production, and decrease the blindness of investment. On the other hand, we should establish and perfect the inspection, quarantine and certification institutions in the process of developing agricultural recycle economy, so as to form the monitoring and service system from top to bottom. We should also conduct comprehensive monitoring on agricultural environment, prohibit the production, sales and use of high-persistent pesticide, and establish the admittance system of agricultural products.

The agricultural recycle economy is the necessary strategic choice for realization of agricultural sustainable development, but there are many difficulties in some agricultural fields with relatively weak economy to develop recycle economy, so in the process of developing agricultural recycle economy, we should give full play to the guiding role of government, establish good environment beneficial to agricultural recycle economic development in order to make the agricultural recycle economy develop steadily.

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