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Prediction on the Farmland Demand of Yunnan Province in 2020 Based on Food Security

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Abstract According to the cultivated area and grain yield during 1996 – 2008 and adopting the prediction method of farmland demand based on food security, five indexes, including the cultivated area, grain sown area, yearly food yield per unit area, total population and per capita grain yield, are selected to analyze and predict the farmland demand in Yunnan Province in 2020. As the prediction results of each index show, the total population of Yunnan Province in 2020 will reach 51 464 000, significantly higher than the upper bound (50 million); the per capita food demand of Yunnan Province in 2020 will be 400 kg below the bottom line of the well-off type; food self-sufficient ratio will be respectively given the value of 100%, 95% and 90% in three schemes; the prediction will be conducted with the yearly food yield per unit area at an average annual growth rate of 2.5% and 3.0% in two schemes; the rate of grain sowing in 2010 is determined to be 66%. As the prediction results of farmland demand show, there are totally 6 schemes about farmland demand in Yunnan Province obtained through analysis, among them, scheme I is difficult to achieve, the prediction results of scheme IV, V and VI are relatively low, which do not conform to the state policies and regulations to protect farmland and are also not conducive for ensuring the food security; scheme II and III are close to each other, but scheme III obtains better prediction results and determines the farmland demand of Yunnan Province in 2020 based on food security to be 5.9 million so as to ensure the provincial food security and realize the "red line" of basic provincial food self-sufficiency.

Key words Food security, Farmland demand, Prediction, Yunnan Province, China

Food security is the basis of the entire security system of a nation and region, China as a country with the largest population but the relative scarce land resources, its food security is always an important factor constraining the development of its agriculture as well as national economy^[1-2]. As one of the most typical mountainous provinces in China's southwestern frontier region, Yunnan is basically characterized by lots of mountains and little flat lands. Since mountains and plateaus account for 96% of the total provincial area, there are very limited arable lands, the overall quality of cultivated lands is poor and the reserve land resources are very scarce^[3]. In view of those above, based on the perspective of food security and according to the relevant data of the cultivated area and grain yield in Yunnan Province during 1996 – 2008, the author adopts the prediction method of farmland demand to predict the farmland demand of Yunnan Province in 2020 so as to provide references for the government's formulation of land protection policies.

1 Prediction methods and source of basic data

1.1 Prediction methods The prediction methods of farmland demand based on food security is a method to achieve the required number of land resources under the circumstances of

ensuring the healthy life of the total population and the food demand in their basic development. The prediction method depends on the size of the regional population growth, per capita food consumption standards, the level of land productivity and various other factors. The calculation formula is as follows^[1,4]:

$$A_d = \frac{P_t \times F_c \times D_s}{Y_a \times R_s} \quad (1)$$

In formula (1), A_d is regional land demand (hm^2); P_t is the total population; F_c refers to the per capita food demand ($\text{kg}/\text{per capita}$); D_s refers to the food self-sufficiency ratio (%); Y_a is the yearly food yield per unit area ($\text{kg}/\text{hm}^2 \cdot \text{a}$); R_s is the rate of grain sowing (%).

It is known from formula (1), the farmland demand of a country and a region depends on five indexes, namely its total population, per capita food demand, food self-sufficiency ratio, yearly food yield per unit area and rate of grain sowing. Among them, the total population and per capita food demand of a country or region jointly decide its total food demand, while the yearly food yield per unit area and rate of grain sowing jointly decide the food production capacity of its arable lands. Therefore, when the food self-sufficiency ratio is set, the regional farmland demand based on food security depends primarily on the total regional food demand and the food production capacity of regional cultivated lands.

1.2 Source of basic data information The basic data information mainly includes the cultivated area, rate of grain sowing, yearly food yield per unit area, total population and per capita food yield during 1996 – 2008 (Table 1). Among them, the number of cultivated area in Yunnan Province during 1996 – 2008 is known from the land survey and change survey conduc-

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ted by Department of Land Resources of Yunnan Province; the rate of grain sowing, total grain output, total population and per capita food yield are cited from the *Yunnan Statistical Year-*

book-2009^[5]; the yearly food yield per unit area is calculated by the cultivated area, the rate of grain sowing, the total grain yield and other basic data.

Table 1 The cultivated area and grain yield of Yunnan Province during 1996 – 2008

Year	Cultivated area//hm ²	Rate of grain sowing//%	Yearly food yield per unit area//kg/ hm ² ·a	Total population// × 10 ⁴	Food yield per capita//kg
1996	6 421 570.71	72.44	2 679.2	4 041.5	308.4
1997	6 405 143.50	71.17	2 790.1	4 094.0	310.7
1998	6 408 230.39	74.42	2 766.8	4 143.8	318.4
1999	6 387 591.11	73.70	2 972.3	4 192.4	333.8
2000	6 339 677.05	72.05	3 213.4	4 240.8	346.1
2001	6 329 846.59	73.18	3 208.6	4 287.4	346.7
2002	6 298 886.41	71.57	3 160.4	4 333.1	328.8
2003	6 187 265.36	70.68	3 363.7	4 375.6	336.2
2004	6 119 551.28	70.60	3 493.9	4 415.2	341.9
2005	6 094 406.91	70.27	3 537.5	4 450.4	340.4
2006	6 077 827.74	69.49	3 451.2	4 483.0	325.1
2007	6 072 357.97	68.85	3 493.8	4 514.0	323.6
2008	6 072 059.95	68.80	3 635.1	4 543.0	334.3

2 Results and Analysis

2.1 Analysis of the predictive value of each index

2.1.1 The index of the total population (P_t). According to the prediction and analysis of relevant departments, it is reasonable to control the total population of Yunnan Province in 2020 within 50 million, a net increase of 4.57 million compared to 2008 with an average annual net increase of 380 800, which is 8.87% less than the average annual net increase of 417 900 during 1996 – 2008. Based on the general census data during 1996 – 2008, the SPSS11.5 software is adopted to conduct the optimal model simulation and prediction. As the results show, the total population of Yunnan Province in 2020 will be 51 464 000, significantly above the control number (50 million).

2.1.2 The index of food demand per capita (F_c). The study conducted by Chinese Academy of Agricultural Science shows that 400 kg of grain per capita is essential^[6–8]. This has become the dominant view about our food security. Seen from China's reform and opening up experience, if the per capita share of food is above 400 kg, then food security gets ensured; if it is between 350 – 400 kg, then food security is tightly balanced; if below 350 kg then food crisis will occur^[9]. On the whole, our country's goal of 400 kg food per capita is still at the low level of food consumption. Under this condition, the per capita consumption of major food are: 230 kg grain, 24 kg meat, 12 kg egg, 10 kg milk and 9 kg aquatic products, still at the transition from subsistence to scientific nutrition, which is only a preliminary to achieve well-off standard of living^[7]. Taking into account the basic condition of the farmlands, population and food production in Yunnan Province, the standard of the per capita share of grain should not be set too high. Therefore, when forecasting the farmland demand, the per capita food demand of Yunnan Province in 2020 based on food security could be determined to be 400 kg (which is the lower limit of well-off type).

2.1.3 The index of food self-sufficiency rate (D_s). *White Paper on China's Grain Problem* points out: "The basic policy to solve our food supply and demand is to fully recognize the do-

mestic resources and realize the basic food self-sufficiency. China will strive to promote the increase of domestic grain productivity, under normal circumstances, the food self-sufficiency rate is no less than 95% and the net imports will be no more than 5% of domestic consumption"^[10]. Yunnan provincial government has always attached great importance to the development of provincial grain production and always emphasized the policy to seek self-sufficiency of grain within the province. *The proposals of CPC Yunnan Provincial Committee on the Eleventh Five-Year Plan of the development of Yunnan provincial economy and society* clearly demonstrates the strategic goals to improve comprehensive agricultural productivity and to ensure the food self-sufficiency^[11]. In view of this, in predicting food demand, it should mainly follow the principle of provincial food self-sufficiency rather than depending on imports. In order to make comparative analysis, the prediction will be conducted in three schemes with the food self-sufficiency rate 100%, 95% and 90% respectively.

2.1.4 The index of yearly grain yield per unit area (Y_a). Since the average annual growth rate of yearly grain yield per unit area in Yunnan Province during 1996 – 2006 has reached 2.97%, taking into account the further promotion of future farmland capital construction and land consolidation, further expansion of land use and the further increase of the investment on materials, labor, science, technology and so on in the agricultural production process will make the average grain yield per unit area get further improvement; and moreover, the serious impact caused by the frequent occurrence of natural disasters in Yunnan Province and the diminishing land returns make it difficult for the grain yield per unit area to maintain a long-term and sustainable great improvement, therefore, the prediction will be conducted in two schemes with the yearly grain yield per unit area during 2009 – 2020 at an average annual growth rate of respectively 2.5% and 3.0%.

Scheme I: The average annual growth rate of yearly grain yield per unit area is 2.5%, then the yearly grain yield per unit area in 2020 will be 5 160 kg/ hm²·a;

Scheme II: The average annual growth rate of yearly grain yield per unit area is 3.0%, then the yearly grain yield per unit area in 2020 will be 4 110 kg/ hm² · a.

2.1.5 The index of rate of grain sowing (R_s). The rate of grain sowing in Yunnan Province has always seen a decline trend. According to the general census data during 1996 – 2008, the SPSS11.5 software is used to conduct the optimal model simulation and prediction. The results show that the rate of grain sowing of Yunnan Province in 2020, 2030 and 2050 respectively reduce to 64.80%, 61.44% and 55.24%, which will

greatly threaten the provincial food security. After a comprehensive analysis, it is reasonable to keep the rate of grain sowing of Yunnan Province in the range 60% – 70%. In this research the rate of grain sowing will be decided to be 66%.

2.2 The analysis of prediction results of farmland demand On the basis of analyzing the predictive value of each index, according to the three schemes of food self-sufficiency rate and two schemes of yearly grain yield per unit area, the farmland demand of Yunnan Province in 2020 based on food security will be predicted from formula (1) (Table 2).

Table 2 The prediction of farmland demand of Yunnan Province in 2020 based on food security

Year	Total population // × 10 ⁴	Food demand per capita // kg	Food demand // × 10 ⁸ kg		
			Food self-sufficiency rate 100%	Food self-sufficiency rate 95%	Food self-sufficiency rate 90%
2008	4 543.0				
2020	5 000.0	400	200.00	190.00	180.00

Year	Yearly grain yield per unit area // kg/hm ²		Rate of grain sowing	Farmland demand × 10 ⁴ // hm ²					
	Scheme I	Scheme II		Scheme I	Scheme II	Scheme III	Scheme IV	Scheme V	Scheme VI
2008	3 635.10	3 635.10	68.80						
2020	4 888.80	5 182.80	66.00	619.85	584.68	588.85	555.45	577.86	526.22

Note : The food self-sufficiency rate of scheme I, II, III, IV, V and VI are respectively 100%, 100%, 95%, 95%, 90% and 90%; the average annual growth rate of yearly grain yield per unit area of scheme I, II, III, IV, V and VI are respectively 2.5%, 3.0%, 2.5%, 3.0%, 2.5% and 3.0%.

As shown in Table 2, at the end year of a new around of overall land use plan revision (2020), a total of 20 billion kg food is needed to meet the preliminary comfortable standard of food consumption (per capita 400 kg) of the total population of 50 million in Yunnan Province, under the conditions of 100% food self-sufficiency rate, if the yearly grain yield per unit area sees an average annual growth rate of 2.5%, then the farmland demand will reach 5 846 800 hm². when the food self-sufficiency rate is 95% (the value proposed in *White Paper on China's Grain*), if the yearly grain yield per unit area grows at an average annual rate of 2.5%, then the farmland demand will reach 5 888 500 hm²; if the average annual growth rate of yearly grain yield per unit area is 3.0%, then the farmland demand will reach 5 554 500 hm².

By the comparison of the above six prediction schemes, scheme I is difficult to achieve, the prediction results of scheme IV, V and VI are relatively low, which do not conform to the state policies and regulations to protect farmland and are also not conducive to ensure the food security; scheme II and III are close to each other, but scheme III is more rational, which is to maintain the food self-sufficiency rate at 95%, keep the yearly grain yield per unit area at an average annual growth rate of 2.5% and the farmland demand of Yunnan Province in 2020 based on food security is 5 888 500 hm².

Outline of the National Overall Planning on Land Use (2006 – 2020) [12] issues that cultivated area of Yunnan Province in 2020 should reach the goal of 5.98 million hm², which is close to the prediction result of scheme III and ensures the food supply and food security in Yunnan Province.

3 Results and Discussions

To predict with the national land use planning and control indexes and the prediction methods of farmland demand in land use planning, it shows that the farmland demand of Yunnan

Province in 2020 based on food security should be around 5.9 million hm², which is the "red line" to ensure the food security of Yunnan Province and achieve the provincial self-sufficiency in food. Moreover, to stick to the "red line" of 5.9 million hm² farmlands is the need to protect the economic and social safety of the whole Yunnan Province and the security of the ethnic minority people. It is also a strategic requirement to protect national food security. This is based on the consideration of following reasons:

① To overstep this "red line" means that, Yunnan Province, as a food production base, its farmland resources get further reduced, which will inevitably affect the increase range of total grain output and make it hard to increase the per capita share of grain, as a result, it not only endangers the provincial food security, but also affects the realization of the goal to build a comprehensive well-off society.

② It is when the yearly grain yield per unit area during 2006 – 2020 maintains at an average annual growth rate of 2.50% and the rate of grain sowing is no less than 66% that the food security of Yunnan Province gets ensured and the lower limit of farmland holdings to achieve provincial food self-sufficiency is maintained. Due to "natural disasters" and other factors, it needs greater investment and more strenuous efforts to make the yearly grain yield per unit area maintain at a relative higher average annual growth rate of 2.5%. Therefore, the "red line" which aims to protect the provincial food security is already very fragile, the overstepping of "red line" plus the irresistible "natural disasters" and other factors, the food security of Yunnan Province will lose basic guarantee.

③ Although this "red line" is expected to ensure 50 million population of Yunnan Province in 2020 to possess 95% of 400 kg per capita grain and basically realize the initial well-off food consumption standard, it does not mean that everyone can achieve that goal. This is because of the vast land, huge popu-

lation and verified regional conditions in Yunnan Province, in the vast mountainous areas (especially in remote alpine mountain), there are still a certain number of people who are difficult to achieve the initial well-off food consumption standard.

From a higher perspective, to adhere to the "red line" of 5.9 million hm² farmlands is the need to ensure the economic and social safety of Yunnan Province and sustainable development of people of all nationalities. Meanwhile, the land resources are the most important basic resources in the whole sustainable development system, if the "red line" of land resources to ensure food security is broken through, the whole sustainable development system will shift to uncoordinated state and even develop towards the "vicious circle" direction. Therefore, in order to maintain the economic and social security of the whole Yunnan Province as well as the sustainable development of ethnic minority people, the "red line" of 5.9 million hm² farmlands in the whole province should be strictly stuck to.

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economic agricultural products in Guilin are typical in that of the whole Guangxi Province, its experiences accumulated in the construction process could provide certain references and guidance for the construction of the supply chain and brand of characteristic economic agricultural products in Guangxi, taking it for reference, the government can take appropriate measures to promote rural economic development in Guangxi and improve the farmers' incomes.

5 Conclusions

The construction of the supply chain and brand of characteristic agricultural products is a systematic engineering, it cannot be completed by a single farmer, enterprise or vendor, nor by a single collective or department, it needs the support and guidance of relevant government departments. Currently, the problems in constructing the supply chain and brands of Guangxi characteristic economic agricultural products, such as that existing in the integrated marketing of the supply chain, the management and protection of the geographical marks of the brands and the cultural integration of regional brands and so on, still need to be solved, which will become a new research topic on the production and develop-

ment of Guangxi characteristic economic agriculture.

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