Carrying Capacity of Cultivated Land in Henan Province

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Abstract According to the 1998 – 2008 *Henan Statistic Yearbook*, Grey Forecasting Model and Time Series Model are used to forecast the carrying capacity of cultivated land in Henan Province. According to the contradiction between limited carrying capacity of cultivated land and the growth of population and food security, we should strictly implement land use planning, enhance the land protection awareness of farmers, establish effective mechanism of cultivated land protection, promote the land economical and intensive use, actively carry out land consolidation, strengthen law enforce, and improve the land use efficiency in order to protect the cultivated land. Result shows that natural population growth rate is gradually reduced in Henan Province and the increasing trend is gradually slowed down, but the population pressure is still relatively great due to the immense population base. Total population of Henan Province of Henan Province will break through 100 million people in the year 2010. In the years 2010 – 2025, grain yield per unit area in Henan Province will show a steady growth trend, with the average annual growth of 10.27%. Existing cultivated land resources in Henan Province can only meet the needs of daily life at the level of adequate food and clothing. With the growth of population, shortage of cultivated land resources is becoming more and more apparent, which will eventually hinder the economic development and the improvement of people's living standard in Henan Province.

Key words Carrying capacity of cultivated land, Grey Forecasting Model, Cultivated land protection, China

Cultivated land is the basis of existence and development of human beings. Stabilizing and expanding cultivated land area, maintaining and improving the production capability of cultivated land is the key to ensuring reasonable land use, stabilizing fundamental position of agriculture and promoting development of national economy. Without decreasing the amount of cultivated land and reducing the quality, we can not further advance modernization of agriculture, constantly upgrade overall grain production capability, and improve the living standard of farmers, so as to eventually achieve the overall, harmonious and sustainable development of rural social economy. However, in the process of economic and social development, along with the growth of the population and the accelerating urbanization process, the contradiction between man and land increasingly highlights. The research of carrying capacity of cultivated land in a region can master the relationship among the cultivated land, grain and population, and determine a reasonable population size and a base line of cultivated land protection. It is also significant to harmonize the relationship between man and land, ensure food security, realize sustainable development of economy and society, and promote the progress of overall well-off society construction[1].

1 General situation of research area

Henan province is located in the middle-east of China, and at the middle and lower stream of Yellow River, 31°23′ – 36°22′N, 110°21′ – 116°39′E. It borders Anhui and Shandong in the east, Hebei and Shanxi in the north, Shanxi in the west, and Hubei in the south. It can be seen as a crossroad connecting north to south, and east to west. It is the transition zone between the north subtropical and the warm temperate zone, so the climate here features four distinct seasons, rain and hot over the same period, various and complicated. The annual mean temperature of the province is 12.6 – 16.6 ℃, mean annual precipitation is 518 – 1 094 mm, yearly non-frost period is 265 – 332 d. The total land area of the province is 167 000 km^2, takes 1.74% of the country's. Henan is not only the Province with large population, but also the biggest grain production base and the important farm produce production base such as cotton, oil plants, tobacco and *etc.* in China. In 2007, the total output of the grain was 52.45 billion kg, the newly-increased grain yield was more than one third of the increment of the whole country; In 2009, the total output of the grain was 53.9 billion kg, and ranked first in the country for the tenth year continuously. Henan's GDP in 2008 was 1.840 778 trillion yuan, increased 12.1% over 2007, continued to rank first in the center-west region and fifth in the whole country, and the GDP per capita was 18 560 yuan.

2 Data sources and research method

2.1 Data sources Data of the research mainly comes from the 1998 – 2008 *Henan Statistic Yearbook* (Table 1).

2.2 Research method Grey Forecasting Model and Time Series Model are used to forecast the carrying capacity of cultivated land in Henan Province.

3 Results and analysis

3.1 Prediction of population Population is one of the important factors that influence the carrying capacity of cultivated land, the prediction of the cultivated land demand should start with the prediction of population. In 2008, the total population of Henan Province was 9.969 million, with 3.573 million urban population and 6.345 million rural population, urbanization rate was 36%. Taking the total population of Henan in 1998 – 2008

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as the original data, the research predicts Henan's population respectively by using time series model ($Y = 62.390\ 91X - 115\ 321$), gray system GM (1, 1) model ($Y = 148\ 864\ 2e^{0.006\ 261\ 961t} - 1\ 479\ 399$, $a = -0.006\ 261\ 961$, $b = 9\ 263.940\ 991$) and mean growth model, and takes the ultimate mean value as the prediction result of population (Table 2).

Table 1 Total population and grain yield per unit area in Henan Province from 1998 to 2008

Year	Population 10^4	Natural growth rate//%	Grain yield per unit area//kg/hm^2
1998	9 243	7.7	4 405
1999	9 315	7.8	4 709
2000	9 387	7.7	4 542
2001	9 488	7.1	4 670
2002	9 555	6.9	4 691
2003	9 613	6.0	4 000
2004	9 667	5.6	4 749
2005	9 717	5.2	5 006
2006	9 768	5.3	5 407
2007	9 820	5.3	5 540
2008	9 869	4.9	5 589

Table 2 Prediction results of population in Henan Province $\times 10^4$

Year	Time series prediction	GM(1,1) model prediction	Mean growth model prediction	Mean
2010	10 084.76	10 080.81	10 017.42	10 061.00
2015	10 396.72	10 401.43	10 332.26	10 376.80
2020	10 708.67	10 732.25	10 657.00	10 699.31
2025	11 020.63	11 073.59	10 991.94	11 028.72

From Table 1, 2, we can see that the natural growth rate of population of Henan Province reduced gradually and the increasing trend is gradually slowed down, but the population pressure is still relatively great due to the immense population base. Total population of Henan Province of Henan Province will break through 100 million people in the year 2010.

3.2 Prediction of grain yield per unit area In recent 10 years, grain yield per unit area of Henan Province changed relatively small. It kept a steady increment in 1998 – 2002, decreased in 2003, but continued to increase steadily in 2004, and had already reached 5 589 kg/hm^2 in 2008 (Table 1). The research takes the grain yield per unit area of Henan in 1997 – 2007 as the basic data, predicts by using time series model ($Y = 105.594\ 46X - 206.644.96$), gray system GM (1, 1) model ($Y = 190\ 445.023\ 2e^{0.022\ 355\ 409\ t} - 186\ 095.023\ 2$, $a = -0.022\ 355\ 409$, $b = 4\ 159.425\ 513$), and takes the ultimate mean value as the prediction result (Table 3).

Table 3 Prediction results of grain yield per unit area in Henan Province kg/hm^2

Year	Time series prediction	GM(1,1) model prediction	Mean
2010	5 599.79	5 630.17	5 614.98
2015	6 127.76	6 296.02	6 211.89
2020	6 655.74	7 040.61	6 848.18
2025	7 183.71	7 873.25	7 528.48

Table 3 shows that the grain yield per unit area of Henan in 2010 – 2025 is steadily increasing, with average annual increment 10.27%.

3.3 Analysis of prediction results With reference to the demand of each material from nutritional standards accepted by international health study, the research predicts the carrying capacity of cultivated land in Henan Province in 2010 – 2025 at 3 levels of living standard which are subsistence type-grain consumption per head 400 kg/a, comfortable type-grain consumption per head 450 kg/a, well-off type-550 kg/a (Table 4).

Table 4 Total required amount of food and cultivated land resources under different life qualities from 2010 to 2025

Year	Total required amount of food//10^4 kg			Year	Total required amount of cultivated land resources//10^4 hm^2		
	Subsistence type	Comfortable type	Well-off type		Subsistence type	Comfortable type	Well-off type
2010	4 024 400	4 527 450	5 533 550	2010	716.73	806.32	985.50
2015	4 150 720	4 669 560	5 707 240	2015	668.19	751.71	918.76
2020	4 279 724	4 814 690	5 884 621	2020	624.94	703.06	859.30
2025	4 411 488	4 962 924	6 065 796	2025	585.97	659.22	805.71

Table 4 shows that under the prediction of population and grain yield per unit area, if Henan wants to reach the subsistence type of life in 2010, the total required amount of food is 40.244 billionkg and the total required amount of cultivated land resources is 7 167 300 hm^2, compares with the total cultivated land resources of Henan in 2008 – 7 926 400 hm^2, the existing cultivated land resources in Henan Province can meet the needs of daily life at the level of subsistence type. But, if wants to reach the comfortable level, Henan needs 45.274 5 billionkg grain, and it requires 8 063 200 hm^2 cultivated land, the existing cultivated land resources can't carry the requirement of comfortable type standard in the future. With the growth of population, shortage of cultivated land resources is becoming more and more apparent, which will eventually hinder the economic development and the improvement of people's living standard in Henan Province.

4 Countermeasures and suggestions

4.1 Strictly implementing land use planning Firstly, put the overall plan of land utilization into effect strictly, take the amount of cultivated land, basic farmland size and scale of construction land for total quantity control. Pay strict attention to compilation of annual land use plan, prequalification of land for construction and approval for land use, hold rigidly to the "three non-approvals, one strictness"[2] (They are non-approval for those which is not in the scope of overall plan of land utilization, has no land-use annual plan target, and hasn't passed the prequalification of land use for construction. Be strictness to ex-

amine the total scale of land use for construction determined by the overall plan). Secondly, harmonize the relationship among overall land use planning, urban planning, construction planning of villages and town, *etc.*, rapidly start the compilation of special planning of land development and consolidation and planning of rural-urban fringe zone, university towns and various park sites, control the total scale of land utilization[3]. Thirdly, strictly control modification and adjustment of the planning and forbid unauthorized modification and adjustment. Fourthly, strengthen the supervision and inspection of the implementation of planning, totally carry out regular evaluation system and plan, prequalification annual inspection system.

4.2 Improving peasants' awareness of protection of farmland On the one hand, we should increase the publicity of cultivated land protection, particularly set up the awareness of basic farmland protection which is related to the national food security, achieving the security baseline of grain self-sufficiency and long-term livelihood of farmers[4]. By using forms of oral interpretation, printmaking publicity typical guidance, and image education to popularize the knowledge of land resources, make sure all the people from central and local governments, administrative officers to the ordinary citizens, farmers can firmly establish the awareness of "Protecting cultivated land is to protect our lifeline"[5]; We should detail land property, further perfect registration and certification sending of rural collective land ownership, and also increase the input and subsidies on agriculture, improve farmland productivity, effectively increase the income of peasants, and raise farmers' awareness of protection farmland.

4.3 Establishing an effective protection mechanism of cultivated land Firstly, we should strengthen the cultivated land balance mechanism between occupancy and compensation, promote the implement of projects linked system between occupancy and compensation, ensure the compensation after occupying one for construction", at the same time, make sure the quality of the compensated cultivated land. Secondly, insist on land use regulatory system, strictly control the occupancy of agricultural land, especially the cultivated land, achieve the optimal allocation of land resource. Thirdly, establish incentive mechanism of cultivated land protection, superior government can link distribution of land index for construction to the condition of cultivated land protection, which means carry out tilt policy in distribution of land target for construction to the towns which made outstanding achievements in cultivated land protection[6]. Fourthly, we should also bring the cultivated land protection into the local government examination mechanism to promote local governments protecting cultivated land actively, and guiding resources utilization and the harmonious development of economy and society[7].

4.4 Promoting economical and intensive land utilization Take scientific distribution of newly increment of land for construction and forceful promotion of circulation of inventory land for construction as the key point, promote economical and intensive utilization of land, systematically analyze the objective situation such as land use features, structure and *etc.* in various businesses to determine the land use quota of each business and improve market access for land-use system. Increasingly tap potential of the existing scale of land for construction. To the enterprises whose land utilization is severely extensive, we should promote concentration of industries in development zones and concentration of farmers in township by the form of "Three Concentrations" on the utilization of inventory land for construction. Meanwhile, we should build an evaluation system and examination system, accelerate to form the reversed transmission of the pressure mechanism, promote the transformation of ways of land utilization and economic growth, strike out a new path of economical and intensive land utilization which is economical, intensive, high-efficient, and high yield[8].

4.5 Actively developing the land consolidation Compendium of Eleventh Five-year Program for National Economy and Social Progress conducts us to further strengthen the land consolidation, particularly the rural land, adjust distribution of rural settlement, improve the use rate of idle land inside the rural settlement and advance the development and reclamation of abandoned land. China has been attaching importance to issues of agriculture all the time, under such a good situation, the project of land consolidation should capitalize on the golden opportunity of new rural communities construction, increase cultivated land effectively, improve the quality of cultivated land and promote the intensive use in the rural settlement. According to the standard of "Fields are square, channels connect net, roads are communicated, forests are in lines" and "Big gully changes into small, open channel changes into covered channel", totally implement comprehensive improvement of fields, water, roads, forests and villages, increase the effective cultivated land area, so as to enhance farmland productivity, reduce the cost, expand the scale of agricultural production and management, and promote agricultural efficiency and farmers' income.

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the laws when their rights to contract the lands are violated.

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农户土地产权意愿研究——以重庆市璧山县大路镇为例

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摘要 以重庆市璧山县大路镇为例,采用问卷调查法,对大路镇 14 个村 3 个社区农户土地产权意愿的总体特点及不同年龄、文化程度、收入水平存在的差异进行探讨,提出了坚持集体所有的改革方向、明确集体所有者、赋予所有者完整的所有权权能、保障农户对土地的用益物权 4 个完善产权制度的建议。结果表明,土地所有权认识模糊,土地私有化倾向不明显,近 2/3 的农户认为农村土地集体所有;土地处分权认识混乱,越权处置土地现象明显,土地的处分权大多数由国家、社集体乃至村委会行使,村委会或者村集体对属于社集体的土地越权处置现象比较明显;不同群体间对所有权认识存在一定差异,不同年龄段、不同文化程度、不同收入水平的农户均呈现对土地所有权认识模糊,土地私有化倾向不明显;不同群体对土地处分权认识存在一定的差异,不同年龄段、不同文化程度、不同收入水平的农户均呈现对土地处分权认识混乱、越权处置土地的特征。

关键词 意愿;农户;调查;土地产权

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河南省耕地承载力研究

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摘要 依据 1998 ~2008 年《河南省统计年鉴》,采用灰色预测模型及时间序列模型对河南省耕地承载力进行了预测,针对现有耕地难以承载不断增长的人口及其粮食安全的问题,提出了严格实施土地利用规划,提高农民自觉保护农地的意识,建立行之有效的耕地保护机制,促进土地节约集约利用,积极开展土地整理工作,加大执法力度,提高耕地利用效率七大保护耕地的措施。结果表明,虽然河南省人口自然增长率在逐渐降低,增长的趋势已渐渐放缓,但是由于基数较大,人口于 2010 年将突破 10 000 万,人口压力依然较大;2010 ~2025 年河南省粮食单位面积产量程平稳增长趋势,平均每年增长 10.27%;河南现有耕地资源仅能承载温饱水平下的人口数量和人民的日常生活,随着人口的不断增长,耕地资源紧缺的问题将会日益突显,最终将阻碍河南经济的发展和人民生活水平的提高。

关键词 耕地承载力;灰色预测;耕地保护 ;灰色预测模型