Analysis on the Balance Between Supply and Demand of Crop Land in Yantai City of China in 2020

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Abstract

With the fast development of economy and urbanization, the phenomenon of city construction occupying Cropland often happens. As the contradiction between human and land becomes more prominent, the contradiction between the supply and demand of the cropland are more radical in Yantai City of China. Analysis on the balance between supply and demand of cropland is the main basis to determine land use objectives, and also the basis of editing land use planning. In this paper, the authors firstly calculated the potential of cropland supply in Yantai for 2020 according to its current number of the cropland and the potential quantity of other kinds of land changing to the cropland, and then calculated the demand for cropland in 2020 with the methods of the population prediction and its national economic development planning. Then the balance between the supply and demand of cropland was analyzed. The results were that the cropland in Yantai city in 2020 were lower than those of its demand. At last, to relieve the contradiction, the authors tried to put forward some recommendations like optimizing the structure to coordinate the balance between the supply and demand of the cropland etc. to realize its regional sustainable development.

Key word: Land; balance between land supply and demand; Analysis; 2020; Yantai

1.Introduction

Land is the source of all existence and production, which is also the mother of wealth. In recent decades, with the rapid development of the city urbanization, population increasing and economy growing , the demand for construction land is increasing, which causes its expanding and leads to its occupation of the crop land from time to time. Crop land is not only the base of agriculture which is the root of human survival, but also an important indicator of the adjustment in the overall land using planning. While the determination of the arable planning indicators relies much on the accurate prediction and reasonable analysis of supply and demand of the crop land. So the analysis of supply and demand of the crop land can not only provide the basis for the overall land use planning, but also coordinate the contradiction of different land use[1]. Therefore, the study of the balance between supply and demand of crop land is of significance to optimize land use structure, to coordinate the land

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quantity balance, to improve the land utilization efficiency and to promote the rapid development of rural economy and society. Only on the base of predicting the land demand correctly, coordinating the supply constraints and the demand guidance and mining the potential of land use sufficiently, can the balance of supply and demand be truly achieved[2]. In the 21st century, Yantai City is facing a grim situation in the insurance of cropland. So predicting the balance between supply and demand of crop land accurately and formulating relevant countermeasures for its sustainable development have very important practical significances to its food security and economy. How to handle the relationship between development and cropland resources correctly, how to ensure the balance between the supply and demand of cropland, have become one of the prominent problems to be solved in the process of implementing sustainable development strategy in Yantai City.

2. **Methodology**

2.1 Research area

Yantai city is located in the eastern part of Jiaodong Peninsula, which is located in mid latitude areas, and is one of the important cites of China's opening to the world with its economy developed quickly. It's coastline lasts 909km with 0.2million hm^2 of shallow beach which could be developed and it is also a famous fishing base[3]. Yantai is rich in natural resources and it is also a base of fruits with many agricultural production. Its climate is the monsoon climate where is temperate and semi humid with four distinct seasons, and its water and heat are in good conditions, which provide favorable climatic conditions for its agriculture development. The region's terrain is mainly mountains and hills with the central parts higher while the south and the north parts lower. The region's plain is mainly the Piedmont and coastal plain, where there is large area of coastal beach. And the soil type mainly includes brown soil, which is arable to crops. Now the total land area of Yantai city is 1.37 million hm^2 , and it has jurisdiction over 7 county-level cities of Penglai, Longkou, Zhaoyuan, Laiyang, Haiyang, Laizhou and Qixia, six districts of Zhifu, Laishan, Muping, Fushan, development zone and high-tech zone, and Changdao County (seen as Figure 1).

Figure 1.The Jurisdictions of Yantai City

Crop land is the main land use in Yantai City, and it is 446.16 thousand hm^2[4]. Nowadays the area of high quality cultivated land is decreasing, and its quality is decreasing, too. In recent years, the expansion of the orchard occupied many high quality cultivated land. And the forest coverage rate in Yantai has increased , with its area of woodland 237.28 thousand hm^2. As the urban construction expands rapidly, its land also occupies the crop land with extensive use and less internal potential. So now the land utilization ratio in Yantai City is very high, and there is fewer reserved land resources. The unused land is in low exploitation degree, most of which are the land of difficult to use.

2.2 Data resources

In this paper, the main data of crop land in Yantai City are from the land bureau, and the data of the region's population and other data come from Yantai statistics yearbook (2001-2011) of statistical bureau.

2.3 Study Methods

2.31 analysis of the supply of cropland in Yantai City

The supply capacity of cropland refers to the land which is potential of being directly used for agricultural production by putting a certain labor development under a certain natural conditions. It often includes the number of all kinds of increased cropland in planning area through land consolidation, reclamation and development. Of course it also includes the decreased part which is occupied by other land use. That is to say, the supply of cropland in 2020 not only includes the cropland that has been used and but also includes the available parts which is suitable for agriculture in the future from other land resource. So in this paper, the supply of cropland was calculated not only on its current number but also on its complement of new cropland and its reduction, and the equation is as formula (1)

$$S_{2020} = P + I - R \qquad (1)$$

In which, S means the supply amount cropland in Yantai City in 2020; P means the present number of the region's cropland; I means the increased number and R means the reduced number of region's cropland. As to the complement of new cropland, we analyzed it from three aspects[6] of land consolidation, reclamation and the development of reserved land resource. That is to say, I equals to C(land consolidation) plus Re (land reclamation)plus D(land development of reserved land resource), so formula (1) can be changed into formula (2). That is:

$$S_{2020} = P + C + Re + D - R \qquad (2)$$

As to R, the reduction of cropland, was predicted by the statistical analysis. Statistical analysis is a research method to understand and reveal the relationships between things, their changing rules and developing trends according to the study on the scale, speed and scope of the research object, so as to achieve the correct explanation and prediction for things[7]. It is very necessary to master the regular patterns of its quantity since

everything in the world has two aspects of quality and quantity. In this paper, statistical analysis was used to calculate R according to the statistical reduction data of cropland in the past years.

2.32 Prediction on the demand for Cropland inYantai City

Cropland is the foundation of human existence and it is a very important index in structural adjustment of land use planning. Now the cropland is mainly used for the cultivation of food crops, so the demand prediction of cropland in Yantai City is mainly determined by its grain demand. The minimum of the region's basic grain demand was used in this article as the foundation of the cropland demand forecasting, the formula is as follows:

$$D = \frac{A * P\,\mathrm{n} * Cp}{d * q * M} \quad (3)$$

In which D stands for the total demand of the cropland (hm^2); A is the regional self-sufficiency rate of grain (%); P_n means regional population in the year n(people); Cp stands for the demand of grain per capita (kg/person); d means the grain production per yield (kg/hm^2); q is the area radio between grain land and the cropland(%); and M means the multiple crop index.

Human beings are the main part of the society and the main producers, so its quantity and construction affect the demands for all kinds of land especially the cropland. With the increase of population, human needs more and more cropland. Therefore, the accurate prediction of the population is one of the key factors to guarantee the land supply and demand balance[8]. It is not only the objective of planning, but also the premise and basis of land layout to determine the land use planning. In this paper, natural population growth model was used to determine the number of people in each period, which is a common prediction method in land use planning. Following is the formula[1]:

$$p_{n=}p_0\left(1+K\right)^{(n-0)}+\left(c-d\right) \quad (4)$$

in which P_n means the population in the planed years; P_0 is the population in the basic years（recent 3years，6.5172 million); n-0 means the period from the base year to the predicted year(12years); K means the natural increased rate of population（Year2004-2009's average 0.87‰）; c is the immigration (83.4K) and d is the emigration during the period from the base year to the planed years (81.2K).

Grain yield forecasting is predicting and calculating the future level of grain production[1]. Theoretically it can be gained based on the compound function of some factors like human factors, natural factors and other factors with formula (5)

$$Y = f\left(x_1, x_2, \ldots x_n\right) \quad (5)$$

In which Y is the prediction of grain yield; $x_1, x_2, \ldots x_n$ are human factors (such as labor, tillage, fertilization, irrigation and others), natural factors (such as soil, light, rainfall, plant diseases and insect pests, climate change, etc.), and other factors (such as crop varieties of agricultural development, agricultural investment etc.). But in

actual operation, these various factors not only affect the grain yield respectively, but also have mutual influences and restrict each other, which increases the difficulty of forecasting. So in this paper grain yield prediction was made by the regression prediction method. Regression prediction method is based on the relationship between variables, and it uses the known values of variables to deduce the prediction variables by establishing mathematical equation between two or more variables[9]. The application of the regression prediction method, therefore, needs two sets of same time sequence which are closely related to each other.

3. Results and Discussions

3.1 the Supply of Cropland in 2020 in Yantai City

3.11 Potential of Land Consolidation

Land consolidation mainly includes agricultural land consolidation and construction land consolidation. The agricultural land consolidation refers to treating the unused land, waste land and farmland with low production comprehensively, so as to improve their land quality and achieve the goal of improving agricultural production conditions[6]. The area of cropland can be increased by adjusting its agricultural structure, merging scattered plots of the rural residents and the scattered cultivated land, since there is a wide distribution of hill in Yantai and a sporadic distribution of plain near its rivers. According to the investigation, most of the coastal plains and the beaches can be used as arable land. And there is an internal hollow phenomenon in some villages and towns, which can be used for the construction of scattered settlements. It is expected that 41.619 thousand hm^2 of the arable land could be increased to 2020 in Yantai City by the land consolidation.

3.12Potential of Land Reclamation

Land reclamation refers to renovating the destroyed land in the production process due to collapse and land occupying by some measures to make them restore to available state[3]. Land reclamation in Yantai city mainly includes renovating the mining waste and seawater encroached arable land. In recent years because abandoned industrial and mining lands, often located in agricultural areas, where there are rich labor resources and land reclamation is relatively easy, many destroyed land were renovated as cropland[10]. If the land reclamation rate remains at 60%~70%, there should be 3.35 thousand hm^2 of cropland through the land reclamation to 2020.

3.13 Potential of Land Development

Land development refers to developing the unused land such as the wild grass land, saline alkali land, swamp, sand and other unused land. According to the survey of land using situation of Yantai City, there was totally 99.837 thousand hm^2 of unused land in 2005[11]. According to the past development rate there would be 21.026 thousand hm^2 of potential arable land to 2020.

Based on the above analysis, the area of cropland in 2020 will increase 65.995 thousand hm^2.

3.14 the Decreasing amount of Cropland

As seen from Figure2,the decreased number of cropland changed with years volatility. So in this paper, the average reduction during 2000-2007 was taken as a 2011-2020 annual average to calculate. And the total reduction to 2020 is 85.47 thousand hm^2.

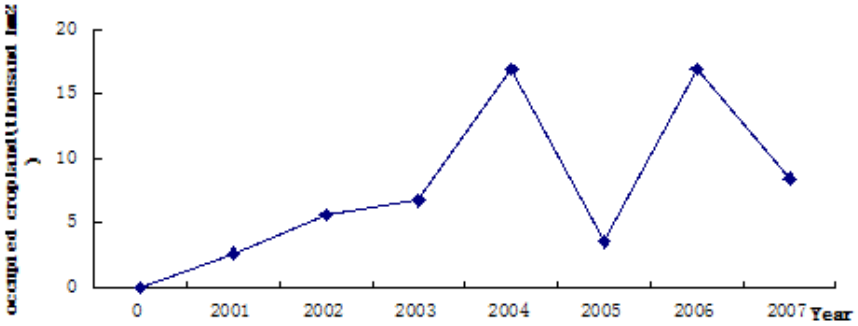

Figure 2. The changing trend of occupied cropland in Yantai from 2000 to 2007

3.2 Demand of Cropland in Yantai City

3.21 Population Prediction of Yantai in 2020

In 2011, the total population of Yantai city was 6.5176 million, and the natural population growth rate and the immigration and the emigration in the past years are seen in table 1 below in details.

Table1. The Population Growth of Yantai in 2001-2011

Year	Population （ten thousand）	NaturalPopulation Growth rate ‰	Immigration (ten thousand)	Emigration (ten thousand)
2002	646.7217	1.13	—	—
2003	645.8232	-1.39	—	—
2004	646.82	1.42	8.25	8.37
2005	647.78	0.76	8.06	8.31
2006	649.98	1.06	9.12	8.15
2007	651.47	0.44	7.92	7.66
2008	651.69	0.96	6.49	6.2
2009	652	0.58	5.97	5.53
2010	651.1376	-1.32	—	—
2011	651.7592	0.95	—	—

Notes：Data from the 2003-2012 statistical yearbook of Yantai city[10].

As can be seen from the table, the city's natural population growth rate is not stable this year, so the average population growth rate is got by the arithmetic mean from 2002 to 2011 and the data of immigration and emigration are predicted by the data of 2004-2009. And through calculations, the population of the city in 2020 will be 6.6178 million.

3.22 Prediction of the Demand for Grain in 2020

According to the research of Chinese Food Industry Association, the demand for food consumption of per capita is 400 kg in 2020. So the total demand for grain in Yantai City in 2020 was calculated with these two factors according to formula（6）:

The total number of the grain demand = food consumption of per capita * Population （6）

And the result is 2.65 million tons of grain. With the consideration of the food goods rate of 30% in recent years the total grain demand is 3.78 million tons.

3.23 Prediction of Grain Yield Level

In 2000, the average grain yield was 4208 kg/hm^2, and to the year of 2006 it became 6750 kg/hm^2 [7]. It can be seen in Figure 3 that the increasing rate kept stable after 2006. The average annual increase is about 363.14 kg/hm^2.

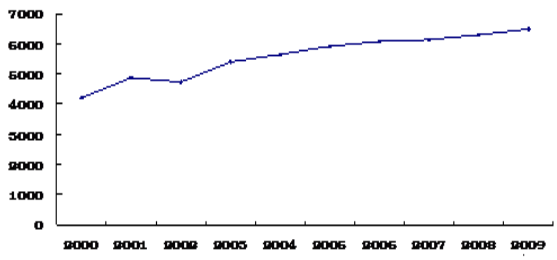

Figure 3. The changing trend of grain yield in Yantai city from 2000 to 2009

Compared to the potential yield level, the current yield level is still low, and the agricultural production level should be further improved. So with the regression analysis method, the grain yield of per unit area of Yantai is predicted as 7952.9 kg/hm^2 in 2020 under the consideration of regional economic development and its land characteristics.

3.24 Demand of Cropland in Yantai City

The multiple cropping index refers to the radio of annual total grain plant area and the area of cropland. According to the recent development of agriculture in Yantai, it is about 1.42[4]. As it is enhanced in 2020, the planned multiple cropping index is 1.52. And from the analysis of statistical data, the area ratio between grain land and cropland is 82%~96%.Considering the food security and with reference of relevant economic development indicators, it can be predicted as 89% in 2020. According to formula (5), the comprehensive demand for cropland in 2020 will be 477.5 thousand hm^2.

4.Conclusions

From the above results and analysis, we can see that through a series measures of land consolidation, land reclamation and development, the area of cropland would increase 65.995 thousand hm^2. But during 2012 to 2020, the regional cropland will be occupied with the area of 85.7 thousand hm^2. So to 2020 the supply of cropland will be 426.16 thousand hm^2. But the demand of cropland will be 477.5 thousand hm^2. The conclusion can be drawn that Yantai will be out of balance in cropland in 2020 since its demand will be far more than its supply. It is very necessary for Yantai to carry out some countermeasures to solve the contradiction, such as implementing the strictest land management system, adhering to the two simultaneously policy of "cutting" and "open source". Only in this way can Yantai achieve the land balance between its supply and demand.

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References

[1]Wang W, Dong J, Wang Q etc. Planning of Land use. Science press.2010.6-10.

[2] Guo Yan, Pan yuan-qing. The balance analysis between land supply and demand in general plans for land use at the county level - taking yanshi for example. Journal of Anhui agricultural science bulletin, 2008, 14 (3) : 17-23.

[3] http://www.yantai.gov.cn/cn/content/about_yt/tjxx/index.jsp，2012-2-2

[4] Land resources bureau of Yantai city. Land use changing table. 2011. 3

[5] Gan Yong-ping, Zhou Xing, Zheng Xiaoping. Method research on the supply and demand forecast of Cultivated land. Journal of geographical research and development, 2002, 21 (4) : 60- 64.

[6]Zhang Qing-mei. The way and effects of Land development and consolidation. Journal of land and resources in Heilongjiang province, 2005, (7) : 38.

[7]Shao Jinhua, Liu Xianzhao. Study on the relationship between cropland quantity change and economic development and population in Yantai. Journal of system science and integrated agricultural research, 2006, 22 (1).

[8]Liu Lei. Population prediction methods comparison and analysis-taking the northeast three provinces for example. The modern commerce industry. 2008, 03 .

[9] Liu Dong, Bai Xuefeng, Meng Jun. Study on China's total grain output multiple linear regression forecast model Based on the forward selection variables method. Journal of northeast agricultural university, 2010, 10.

[10] Yantai bureau. Yantai statistical yearbook. 2002-2012.

[11] People's government in Yantai city. The current land use in yantai. 2006.

[12] Cheng Shao-wen and Zhang Yi. Analysis and prediction of supply and demand of cultivated land in hubei province potential research. Journal of agricultural resources and regionalization in China,2005, (4) : 18 to 22
[13] Li Feng-qin, Li Jiangfeng, Meng Puwei. Research on land ownership forecast method in General land use planning. Journal of anhui agricultural science, 2007, 35 (1) : 168-169.