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The Supply and Demand of Agricultural Products in China Based on Balanced Diet

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Abstract Promoting agricultural production and ensuring the supply of agricultural products has always been the main task of agricultural development in China, but the agricultural production in China has not yet been combined with the Chinese residents' dietary needs to formulate reasonable development goals, with a certain blindness in production. According to the dietary standards in *The Dietary Guidelines for Chinese Residents* developed by the Chinese Nutrition Society, we calculate the demand of various types of agricultural products in China under the conditions of balanced diet. In comparison with the output of various types of agricultural products in China at present, we find that the output of most of agricultural products in China has exceeded the reasonable demand of the Chinese residents under the conditions of balanced diet. Therefore, adjusting the agricultural production structure in China and advocating balanced diet has become an important way to solve the problem of balance between supply and demand of agricultural products.

Key words Balanced diet, Agricultural products, Supply and demand

Developing agricultural production and ensuring the balance between supply and demand of agricultural products in China, has always been the main objective of China's agricultural development, and the basis of the various types of agricultural policy formulated by China. The predecessors have made a lot of researches on the balance between supply and demand of agricultural products in China and the related agricultural policies. Han Jun *et al.* ^[1] believe that with population growth, rise in the level of residents' income and advance of urbanization, China has stepped into the stage of rapid growth in demand for agricultural products; the supply and demand of agricultural products tend to be tight on the whole, and the imbalance between supply and demand of some agricultural products is obvious; the dependence of agriculture on the international market is gradually increased. Ma Xiaohe *et al.* ^[2] hold that in order to solve the problem of balance between supply and demand of China's major agricultural products in the new era, there should be both the concept of dynamic equilibrium, and the idea of regional balance. At the same time, under the conditions of further opening up, we must adopt new comprehensive agricultural policy measures. Zhang Xiaoshan ^[3] believe that the phenomenon of good agricultural development situation and continuous rise in the consumer prices occur in the pattern of the supply and demand of agricultural products in China; these new changes are closely related to some factors having long-term effects on changes in the relationship between supply and demand of agricultural products, such as continuous growth in urban and rural residents' demand for agricultural products, dwindling agricultural land resources, and structural gap in relation-

ship between supply and demand of some agricultural products. The government should balance relationship of interests between producers and consumers, and stabilize the market prices of agricultural products. The previous researches are mainly based on the supply and demand situation of agricultural products at that time, failing to combine the demand for agricultural products in China and the residents' balanced diet in China, determine a type of reasonable demand for agricultural products and develop appropriate agricultural policy. The release of *The Dietary Guidelines for Chinese Residents* in 2007 provides a basis for measuring the demand of various types of agricultural products in China ^[4]. Therefore, based on the recommended standard in *The Dietary Guidelines for Chinese Residents*, we estimate the demand of various types of agricultural products in China, compare it with production and supply situation of various types of agricultural products in China, and then put forward the direction of the agricultural restructuring in China, in order to provide a reference for the formulation of agricultural policy in China.

1 Analysis of demand for various types of agricultural products in China under the conditions of balanced diet

1.1 Measuring of theoretical demand of various types of agricultural products in China under the conditions of balanced diet *The Dietary Guidelines for Chinese Residents* developed by the Chinese Nutrition Society (2007) is the reference standard drawn up based on scientific evidence, closely in conjunction with the Chinese residents' actual dietary nutrition. From the point of view of nutrition and health, *The Dietary Guidelines for Chinese Residents* gives the food intake under a variety of energy levels, and the dietary standards it advocates will be of great guiding significance in the next decade ^[5]. We

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regard this indicator as the basis for estimating the demand of various types of food in China.

The Dietary Guidelines for Chinese Residents divides the food that people need to ingest per day into five levels: grain, potatoes and beans; vegetables and fruits; livestock and poultry meat, fish, shrimp, and eggs; milk and dairy products, soybeans and nuts; grease. Since grease is processed agricultural product, correlated with the production of grain and livestock products, including vegetable oil and animal oil, we do not consider it in the study. According to the division of food by *The Dietary Guidelines for Chinese Residents*, combined with the actual production of the Chinese agriculture, the agricultural products are divided into 8 categories: cereals, potatoes and beans; vegetables; fruits; livestock and poultry meat; aquatic products; eggs; milk and dairy products; soybeans and nuts.

We make the following assumptions prior to the study. (i) From purchase to eating of grain and potatoes, livestock and poultry meat, eggs, milk and dairy products, soybeans, nuts

and other agricultural products, the loss in the middle course is 10%, and the adjustment coefficient is 1.05. (ii) From the purchase to eating of vegetables and fruits by consumers, the loss is 10% and the adjustment coefficient is 1.11. (iii) *The Dietary Guidelines for Chinese Residents* gives value interval of the general healthy adults' daily consumption of each kind of food. The fluctuation in this interval is relatively large, so we ignore individual differences in the study, and conduct research in accordance with the lowest and highest values, respectively. (iv) The population is calculated according to China's urban and rural population in *China Statistical Yearbook* in 2009.

According to the reference standard of milk and dairy products, livestock and poultry meat, fish and shrimp, eggs, vegetables, fruits, grain potatoes, beans and other food, consumed by everyone per day in *The Dietary Guidelines for Chinese Residents* (2007), various types of food that everyone needs to consume annually are calculated, which can be shown in Table 1.

Table 1 Demand of various types of agricultural products in China under the conditions of balanced diet

Demand	Milk and dairy products	Soybeans and nuts	Livestock and poultry meat	Fish and shrimp	Eggs	Vegetables	Fruits	Cereal, potato and beans
Recommended daily demand value//g	300	30 – 50	50 – 75	75 – 100	25 – 50	300 – 500	200 – 400	250 – 400
The annual number of days//d	365	365	365	365	365	365	365	365
Adjustment coefficient	1.05	1.05	1.05	1.05	1.05	1.11	1.11	1.05
The lowest annual per capita demand//kg	114.98	11.50	19.16	28.74	9.58	121.55	81.03	95.81
The highest annual per capita demand//kg	114.98	19.16	28.74	38.32	19.16	202.58	162.06	153.30
Population//10 ⁴ people	133 474	133 474	133 474	133 474	133 474	133 474	133 474	133 474
The national annual minimum demand//10 ⁴ t	15346	1535	2558	3837	1 279	16 224	10 816	12 789
The national annual maximum demand//10 ⁴ t	15346	2558	3837	5116	2 558	27 040	21 632	20 463

1.2 Measuring of the actual Chinese residents' consumption of various types of food

In order to analyze the Chinese residents' consumption of various types of food, we conduct calculation according to the relevant data in *China Statistical Yearbook*. As the statistics of *China Statistical Yearbook* concerning the urban residents are the amount of various types of food purchased by residents, the Chinese urban residents'

consumption of dining outside is not considered. According to the research of Ma Guansheng, *et al.* [6], the proportion of the Chinese urban residents dining outside is 26.1%. Based on the proportion, we adjust the calculation of data on livestock and poultry meat, aquatic products, eggs, vegetables and grain. After adjustment, the actual Chinese residents' consumption of various types of food can be shown in Table 2.

Table 2 The Chinese urban-rural residents' consumption of various types of food

Consumption	Milk and dairy products	Soybeans and nuts	Livestock and poultry meat	Fish and shrimp	Eggs	Vegetables	Fruits	Cereal, potato and beans
Urban residents' per capita consumption//kg	14.91	11.22	46.85	16.96	14.28	162.77	56.55	109.91
Rural residents' per capita consumption//kg	3.6	11.22	19.58	5.27	5.32	98.44	20.54	189.26
Urban residents' total annual consumption//10 ⁴ t	927.21	697.75	2 913.64	1054.71	888.32	10 123.01	3 517.01	6 835.46
Rural residents' total annual consumption//10 ⁴ t	256.64	799.87	1 395.88	375.71	379.28	7 018.18	1 464.40	13 493.48
Total consumption//10 ⁴ t	1 183.85	1 497.62	4 309.52	1 430.42	1 267.60	17 141.19	4 981.41	20 328.94
The national per capita consumption//kg	8.87	11.22	32.29	10.72	9.50	128.41	37.32	152.29

Note: The annual per capita consumption data are from *China Statistical Yearbook* in 2009; due to the missing of data on urban per capita consumption of aquatic products data in 2009, we use the data in 2005 instead; as most of current China's domestic soybeans are used to produce soy products, we use China's soybean yield data in 2009 to replace soybeans and nuts data.

1.3 Rationality analysis of the Chinese residents' consumption of various types of food In order to analyze whether the Chinese residents' consumption of various types of food is in line with the standard of balanced diet, we compare the Chinese residents' consumption of various types of food with the standard of balanced diet.

1.3.1 Food consumption structure of China's urban residents is very unreasonable. Through comparison between the Chinese urban residents' consumption of various types of food and the consumption under the conditions of balanced diet, we find that the Chinese urban residents' food consumption structure is very unreasonable. The consumption of livestock and poultry meat is 1.63 times more than the maximum limit. The consumption of milk and dairy products is far less than the minimum value; the consumption of fish and shrimp and fruits is less than the minimum value; the consumption of soybeans and nuts is slightly lower than the lowest value. Only the consumption of vegetables, eggs, grain, potatoes and beans is between the lowest and highest values, which is relatively reasonable (Fig. 1). It indicates that the main problems in the Chinese urban residents' food consumption structure are that the consumption of livestock and poultry meat is too high, while the consumption of milk is insufficient.

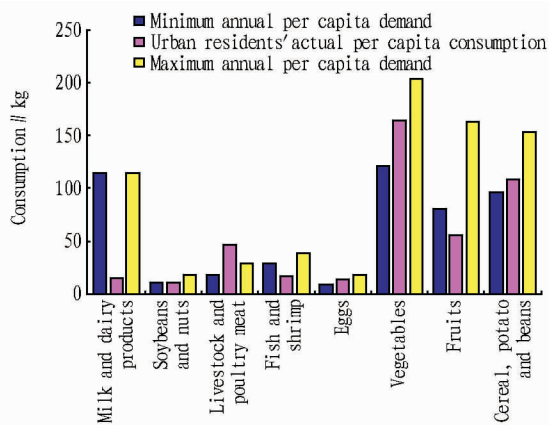


Fig. 1 Comparison between urban residents' consumption of various types of food in China and balanced diet consumption

1.3.2 Rural residents' consumption of various types of food in China is not very reasonable. Through comparison between the Chinese rural residents' consumption of various types of food and the consumption under the conditions of balanced diet, we find that the Chinese rural residents' food consumption structure is also unreasonable. In 8 types of food, only the consumption of livestock and poultry meat is slightly higher than the minimum consumption; the consumption of soybeans and nuts is slightly lower than balanced diet consumption; the consumption of dairy products, fish and shrimp, eggs, vegetables, and fruits, is far below the minimum value of the consumption of balanced diet. Only the consumption of grain, potatoes and beans is higher than the highest value, which can be shown in Fig. 2. The main problems in the food consumption structure of rural residents in China are that the consumption of grain, potatoes and beans is too high, while the consumption of vegetables, fruits, fish and shrimp, and eggs is too low. This is mainly because the level of the Chinese rural residents' income is not high; food is still con-

centrated in grain; the consumption of vegetables, fruits, aquatic products and other food is too little.

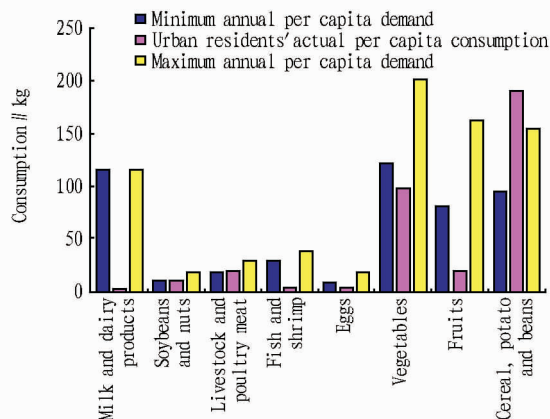


Fig. 2 Comparison between rural residents' consumption of various types of food in China and balanced diet consumption

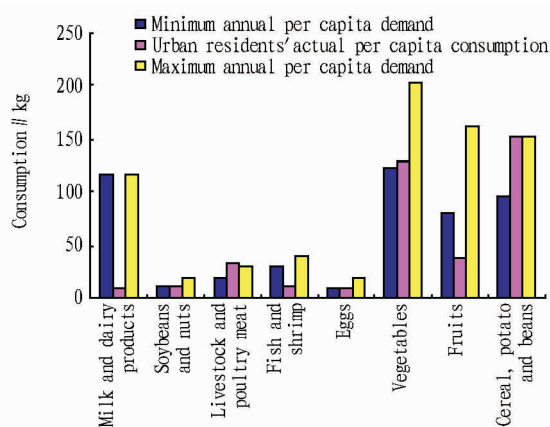


Fig. 3 Comparison between the Chinese residents' consumption of various types of food in China and balanced diet consumption

1.3.3 Overall situation of the Chinese residents' consumption of various types of food. From the situation of the national average, the Chinese residents' soybeans, nuts and eggs are close to the minimum demand of balanced diet; milk and dairy products, fish and shrimp, fruits are far less than the minimum value of balanced diet; grain, potatoes, beans and vegetables are at a more reasonable level; the consumption of livestock and poultry meat is more than the highest value of balanced diet (Fig. 3). At present, the most important issue in the Chinese residents' consumption of balanced diet is that the consumption of livestock and poultry meat is too high, while the consumption of other types of food is relatively short.

2 Analysis of supply and demand of various types of agricultural products in China under the conditions of balanced diet

2.1 Analysis of supply and demand balance of agricultural products in China under the conditions of balanced diet

Under the strong support of the national policy, the production of various types of agricultural products in China has al-

ways been in a state of rapid growth. In the period 2000 – 2009, China's grain output increased from 462 million t to 531 million t, the total output of meat increased from 60.14 million t to 76.49 million t, poultry and eggs increased from 21.82 million t to 27.4 million t, the output of milk increased from 9.19 million t to 37.34 million t, the output of aquatic products increased from 37.06 million t to 51.16 million t, the output of vegetables increased from 424 million t to 618 million t, and the output of fruits increased from 62.25 million t to 203.95 million t, an increase of 14.94%, 27.19%, 25.57%, 306.31%, 38.05%, 45.75%, and 227.63%, respectively. The growth rate is far greater than China's population growth rate of 5.31% in the

same period^[7]. The increasing supply of agricultural products in China significantly improves the nutritional status of the Chinese residents.

In order to analyze the supply and demand balance of the China's agricultural products under the conditions of balanced diet in China, we conduct comparative analysis of the production of China's agricultural products in 2009 and the demand for various types of food in 2009. Since the imports and exports of various types of agricultural products in China are relatively small as against the output, we view the output as the supply for consideration, and the specific results are shown in Table 3.

Table 3 Supply and demand of various types of agricultural products in China under the conditions of balanced diet

Demand	Milk and dairy products	Soybeans and nuts	Livestock and poultry meat	Aquatic products	Eggs	Vegetables	Fruits	Cereal, potato and beans
The national minimum demand//10 ⁴ t	15 346	1 535	2 558	3 837	1 279	16 224	10 816	12 789
The national maximum demand//10 ⁴ t	15 346	2 558	3 837	5 116	2 558	27 040	21 632	20 463
The national yield in 2009//10 ⁴ t	3 734	1 498	7 649	5 116	2 740	61 823	20 395	53 082

Note: Data are from *China Statistical Yearbook* 2010.

It can be seen from Table 3 that the output of livestock and poultry meat in China is 2 times more than the Chinese residents' demand under the conditions of balanced diet; the output of aquatic products is equal to the maximum demand under the conditions of balanced diet; the output of eggs is also more than the maximum demand under the conditions of balanced diet; the output of vegetables is 2.29 times more than the demand under the conditions of balanced diet; the output of fruits is close to the maximum demand. Judging from the data, the output of grain, potatoes and beans in China is 1.59 times more than the maximum demand, but most of the grain is used for feed production rather than direct consumption, therefore, the Chinese residents' direct consumption of grain, potatoes and beans, namely food consumption, is guaranteed.

Generally speaking, the output of most of China's agricultural products is more than reasonable demand under the conditions of balanced diet. We cannot meet the Chinese residents' dietary needs merely by the production of milk and dairy products, on the one hand, because China's agricultural production policy is not linked with the dietary needs of the Chinese residents, lacking macroeconomic coordination; on the other hand, because the Chinese residents pay little attention to healthy diet, and do not attach importance to balanced diet, but only attach importance to glutting themselves with delicacies and consuming a lot of meat.

On the one hand, the relative surplus of production of various types of agricultural products in China, directly makes the prices of agricultural products in China difficult to rationally return, the majority of farmers fail to share reasonable industry profits from the production, and the farmers difficult to increase their income, so that increase in the farmers' income is more and more dependent on the income from non-agricultural industries; large tracts of farmland is abandoned; increase in the agricultural output is more and more difficult. On the other hand,

the relatively low prices of agricultural products also contribute to serious food waste in China. Considerable kitchen waste not only exerts tremendous pressure on China's ecological environment, but also provides opportunity for the unscrupulous traders' illegal production using the kitchen waste. Moreover, in order to maintain the level of the supply of Chinese agricultural products, considerable fertilizers, pesticides, veterinary drugs, various types of growth hormone, and other means of production, are applied in the process of agricultural production, not only causing degradation of agricultural production environment in China, but also affecting sustainability of the Chinese agriculture. At the same time, the fertilizer resources are scarce in China, largely dependent on imports, so the impact of the international market on agricultural production in China is also increasing.

2.2 Demand of various types of agricultural products in China in 2020 under the conditions of balanced diet According to the Chinese residents' balanced diet standard, we calculate the demand of various types of agricultural products in China in 2020, based on the technical level of China's agricultural production. The population is determined as generally recognized 1.45 billion for calculation^[5]. China's grain is not only regarded as food for people, but also regarded as feed grain and industrial grain^[8]. According to *The Dietary Guidelines for Chinese Residents* (2007), Hu Xiaoping, *et al.*^[5] predict the demand of China's grain in 2020, and here we directly cite their prediction result of 610 million t. As for other types of agricultural products, we can refer to the prediction method developed by Hu Xiaoping, *et al.*^[5]. The demand of various types of food is calculated, by taking the arithmetic mean of the lowest and the highest amount recommended by the dietary standard, then raising 10%. Demand of various types of agricultural products in China in 2020 under the conditions of balanced diet is calculated, as is shown in Table 4.

Table 4 Demand of various types of agricultural products in China in 2020 under the conditions of balanced diet

Item	Milk and dairy products	Soybeans and nuts	Livestock and poultry meat	Aquatic products	Eggs	Vegetables	Fruits	Cereal, potato and beans
Annual per capita demand//kg	126	17	26	37	16	178	134	–
Total demand in 2020 //10 ⁴ t	18339	2445	3820	5348	2292	25849	19386	61000
Supply in 2009 //10 ⁴ t	3734	1498	7649	5116	2740	61823	20395	53082

It can be seen from Table 4 that the major industry in China needing to be vigorously developed in the future is the dairy industry; the output of China's milk falls far short of the demand of balanced diet. The livestock and poultry breeding industry and vegetable growing industry need to be vigorously adjusted. At present, the scale of production of livestock and poultry meat and vegetables in China has been more than double the demand under the conditions of balanced diet in 2020. Even if considering the loss rate of China's vegetables is in 15%–20% after picking, it still has huge room for adjustment. After the reduction of livestock and poultry meat yield, we can reduce half of China's feed grain consumption and alleviate the pressure on China's grain production. After the adjustment of vegetable products, there will be more arable land for food production. For the nonce, there is still a certain gap between China's grain output and the demand in 2020, and food production is also the direction that the China's agricultural production continuously and sedulously maintains. The current output of soybeans, aquatic products, eggs and fruits in China, is almost commensurate to the demand, so appropriate adjustments serve the purpose.

3 Conclusions and recommendations

3.1 Conclusions China has always regarded yield increase as the goal of agricultural development, lacking macro-control over production according to the Chinese residents' dietary needs, so that the output of livestock and poultry meat and vegetables in China exceeds the demand of the Chinese residents balanced diet. Therefore, the agricultural production in China has huge room for adjustment.

The publicity of relevant departments in China for balanced diet is not enough, making the Chinese urban residents' intake of livestock and poultry meat exceed the maximum value of balanced diet, but intake of milk is seriously short. Due to low income, the food of China's rural residents is still focused on grain, and the intake of grain food is relatively high, but the consumption of vegetables, fruits, fish and shrimp and eggs is very small. The dietary pattern of Chinese residents is very unreasonable, and the dietary pattern of rural residents is more reasonable than that of urban residents.

Under the conditions of balanced diet, by comparing the demand of various types of agricultural products in China in 2020 and supply of various types of agricultural products in China in 2009, we find that the output of livestock and poultry meat and vegetables in China in 2009, has greatly exceeded the demand. There is a serious shortage of milk output and food yield, so it is the future direction of China's agricultural produc-

tion efforts. The current output of eggs, aquatic products, fruits and soybeans can basically meet the demand.

3.2 Recommendations

3.2.1 Vigorously advocating balanced diet and changing the Chinese residents' eating habits. The Chinese residents' unscientific eating habits are the root cause of issues concerning the supply and demand of agricultural products in China. In order to solve the contradiction between supply and demand of agricultural products in China, we should first change the Chinese residents' unscientific eating habits. China's public health departments and other relevant departments should step up publicity to advocate balanced diet, and the reduction of the intake of livestock and poultry meat. On the one hand, it is conducive to easing the contradiction between supply and demand of agricultural products in China; on the other hand, it is also conducive to improving the health level of the Chinese residents.

3.2.2 Gradually reducing the scale of livestock and poultry breeding. The livestock and poultry breeding is not only related to China's supply of meat, but also related to China's grain production. The livestock and poultry breeding scale in China is too large, not only making China's supply of meat exceed the reasonable demand under the conditions of balanced diet, but also causing tremendous pressure on China's grain production. China's grain yield has made great achievements of "increase in seven successive years", but due to the continuous development of China's livestock production, the imported soybeans in China are increased year by year. In 2010, the imported soybeans were more than 50 million t, accounting for nearly 10% of China's grain output^[9], causing tremendous risk to China's food security. Gradually reducing the scale of China's livestock production to make it return to a reasonable level, is a key solution to the current plight of agricultural production.

3.2.3 Making the price of grain, meat and other animal products rise moderately in the controllable range. On the one hand, moderate rise in the prices of agricultural products such as grain and meat, can inhibit the Chinese residents' consumption of livestock and poultry meat, reduce meat intake, and improve the health of residents; on the other hand, moderate rise in the prices of agricultural products is also conducive to making the farmers share reasonable industry profits, mobilizing the enthusiasm of farmers to grow grain and expand the sown area of grain, and protecting the security of supply of agricultural products in China. Since the reform and opening up, Chinese residents' Engel coefficient has been declining, and the growth rate of residents' income has been far greater than the rise rate of prices of agricultural products. Therefore, making the prices of agricultural products rise moderately, will not affect social

stability, but will help protect the security of supply of agricultural products in China.

3.2.4 Gradually reducing the scale of open field vegetable production and vigorously developing the facility vegetables. According the previous calculation, at present, China's vegetable output has far exceeded the Chinese residents' demand under the conditions of balanced diet. We can reduce the production area of open field vegetables, and encourage the development of facility vegetables to increase the output of vegetables per unit area, and increase the land resources for the production of oil crops, grain and other agricultural products, in order to ensure the balance between supply and demand of agricultural products in China.

3.2.5 Vigorously developing dairy industry to meet the nutritional needs of Chinese residents. The output and consumption of dairy products are both seriously lower than the standard of balanced diet for the Chinese residents. The dairy industry is the main direction of China's future livestock production. By expanding the supply of milk and dairy products, on the one hand, it can meet the Chinese residents' needs for balanced diet; on the other hand, it can make up for the nutrient deficiency after the intake of livestock and poultry meat is reduced.

3.2.6 Vigorously developing the soy milk and other milk and dairy product substitutes. In many areas of China, the residents do not have the habit of consumption of milk and dairy products; there is a great difference between milk intake and supply in China, and the development pace of dairy industry can not meet demand. Therefore, China should vigorously develop the soy milk and other milk and dairy product substitutes.

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