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# Empirical Analysis on the Grain Supply Capacity of Hubei Province, China

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**Abstract** According to the investigation results of grain production and demand status of administrative units at county level in Hubei Province in the years 2004–2007, status and trend of grain production and grain demand in Hubei Province are analyzed, so as to discuss the grain supply capacity of Hubei Province. Result shows that affected by the adjustment of agricultural structure and the transfer of rural labor, Hubei Province shows a significant decrease in grain production before the year 2002, and a gradual increase in both grain production scale and grain supply capacity after the year 2004. It is forecasted that in the year 2020, Hubei Province will provide 13 100 thousand tons marketable grain to the state and will become a core province ensuring the grain security of China.

**Key words** Grain production, Ration, Grain supply capacity, Hubei Province, China

Since the 1980s, China has provided adequate grain, and the situation of grain security has fundamentally been improved. Security level in China has been at the forefront of developing countries, and some indices even have reached the level of developed countries. The basic level of grain security for a country is providing the adequate grain ration for its people<sup>[1]</sup>. Commodity grain production bases play a key role in ensuring the national grain security. The national grain security system is established based on the grain supply and demand balance of subsystems in provinces (municipalities and autonomous regions). Research on the provincial grain supply and demand balance helps to analyze the its own grain security level and its contribution to the national grain security strategy, and to correctly understand the dominant function of regional agriculture<sup>[2]</sup>. Hubei Province is a key province for the grain production of China; and Jiangnan Plain in Hubei is one of the nine bases for commercial grain production in China<sup>[3]</sup>. The total output of grain in the year 2007 is 25 340.7 thousand tons, ranking the tenth in China. Among them, output of paddy rice is 16 840.2 thousand tons, ranking the fourth; output of wheat is 3 811.2 thousand tons, ranking the eighth. Except the grain for self-sufficiency in the province, perennial net grain transfer of grain is about 500 thousand tons. Due to the adjustment of regional economic structure, the rapid development of urbanization, and the transfer of rural labor forces, there is huge changes in the regional distribution of the balance between grain production and supply. Therefore, it is of great importance to study on the grain supply capacity of Hubei Province, China.

## 1 Data acquisition and research method

### 1.1 Data acquisition

Taking county-level administrative unit

as the research unit, grain supply and demand status of the county-level administrative units in Hubei Province in the years 2004–2007 is investigated, including the indices of overall population (permanent population), urban population, rural population, rural per capita ration, urban per capita grain consumption, total output of grain, paddy yield, wheat yield, cultivated land area, and grain commodity rate. Survey data are collected by the report of counties (cities), and the error are corrected by compilation and verification. Some of the data are obtained from the handbook for leading cadres in Hubei Province (2008) and the *Hubei Statistical Yearbook* (2008)<sup>[4–5]</sup>.

### 1.2 Research method

**1.2.1** Trend analysis and forecasting method of grain output. Analysis of grain output mainly calculates the annual average change rate of grain output based on the sowing area of major food crops and the Time Series Trend Analysis of unit yield change. Trend extrapolation of the annual average growth rate of grain output in recent four years is carried out, in order to forecast the regional grain output levels in the short and long terms.

**1.2.2** Calculation method for the grain consumption demand. Grain consumption demand includes the grain direct consumption demand and the indirect grain consumption demand in urban and rural areas. Grain direct consumption of residents refers to the grains ration for rural residents and the consumption of urban residents (short for ration); indirect grain consumption demand refers to the grain demand for the meat food production.

The equation for the forecast of the ration demand is

$$Q = q_r \times P_r + q_t \times P_t \quad (1)$$

where  $Q$  is the overall regional ration demand,  $q$  is the grain consumption per capita,  $r$  is rural area,  $t$  is township, and  $P$  is the overall population. Forecast of grain output is calculated by the average growth rate of grain output. Indirect grain consumption demand is converted into grain needed by the poultry according to the feed conversion standard.

## 2 Result and analysis

### 2.1 Analysis on the grain production and consumption status in Hubei Province

**2.1.1** Current status of grain production. The total output of grain reaches 25 340.7 thousand tons in Hubei Province in the year 2007. Major food crops mainly include the rice, wheat, corn and other grain crops. Sowing area of wheat, rice and corn is 4 034.8 thousand hectares, accounting for 55.71% of the overall sowing area of crops. The total output of wheat, rice and corn is 22 986.1 thousand tons, accounting for 90.71% of the overall grain output. Other crops, such as soybean, barley, and potato, have an overall output of 2 354.5 thousand tons, accounting for 9.29% of the overall grain output. Among the rice, wheat and corn, sowing area of rice is 2 594.3 thousand hectares, and its output is 16 840.2 thousand tons, accounting for 66.46% of the overall grain output. Sowing area of wheat is 959.1 thousand hectares, and its output is 3 811.2 thousand tons, accounting for 15.04%. Sowing area of corn is 481.4 thousand hectares, and its output is 2 334.8 thousand tons, accounting for 9.21%.

**2.1.2** Current status of grain consumption demand. Average annual grain consumption per capita is 248 kilograms in Hubei Province. Among them, rural annual grain consumption per capita is 278 kilograms; and the urban annual grain consumption per capita is 210 kilograms, which is about 70 kilograms less than the rural annual grain consumption per capita. According

to the regional distribution, there are great regional differences in urban and rural per capita grain consumption. Annual grain consumption per capita in mountain areas is significantly higher than that in plain areas. Annual grain consumption per capita in towns and cities in mountain areas is more than 300 kilograms. Especially, the consumption per capita is as high as more than 400 kilograms in Lichuan City and Hefeng County in southwest Hubei Province and the Dabie Mountains in northeast Hubei Province. But the consumption per capita is less than 250 kilograms in cities and towns in plain areas. The average grain consumption per capita in rural areas has similar distribution rules with the average grain consumption per capita in urban and rural areas. And the former has more significant difference than the latter. Average grain consumption in towns and cities in mountain areas is far greater than that in plain areas. Farmers in plain areas have obtained rapid income increase, showed significant increase in grain consumption, and need more consumption of meat and aquatic products than the mountain areas. Table 1 reports the grain consumption per capita in cities of Hubei Province. Annual grain consumption per capita in Wuhan, Huangshi, Tianmen and Xiantao, which are located in the hinterland of Jiangnan Plain, is less than 220 kilograms; urban and rural per capita annual grain consumption in Enshi and Xianning is at about 300 kilograms or above. And other prefecture-level cities are at about 230–290 kilograms.

**Table 1** The grain consumption per capita in Hubei Province, China

	The grain consumption per capita in rural areas//kg	The grain consumption per capita in urban areas//kg	The grain consumption per capita in Hubei//kg	Total grain consumption in rural areas $\times 10^4$ kg	Total grain consumption in Hubei// $\times 10^4$ kg
Wuhan City	294	165	210	90 063.48	184 734.34
Huangshi City	257	170	220	35 564.19	53 052.66
Ezhou City	290	210	269	22 028.25	27 717.86
Xiaogan City	276	205	249	79 855.10	116 325.59
Huanggang City	280	198	250	118 259.90	166 970.81
Xianning City	312	282	300	47 346.99	75 453.62
Jingzhou City	292	225	261	91 611.71	152 891.58
Yichang City	256	220	247	77 268.83	99 731.09
Jingmen City	318	229	290	53 783.93	82 463.02
Xiangfan City	263	220	242	72 880.17	131 580.88
Suizhou City	283	159	235	38 382.64	52 012.90
Shiyan City	263	225	249	54 593.52	80 715.92
Enshi	344	250	315	83 048.94	109 910.69
Tianmen City	212	192	203	15 856.74	28 206.83
Xiantao City	220	195	206	13 585.11	28 260.15
Qianjiang City	243	220	231	11 073.90	21 752.59
Shennongjia Forest Area	246	220	233	910.39	1 708.65
Hubei Province	278	210	248	891 184.60	1 413 765.33

Table 2 reports the permanent residents, rural population and total grain consumption in Hubei Province in the years 2004–2007. In the year 2007, number of permanent residents in Hubei Province is about 56 990 thousand. Among them, rural population is 31 743 thousand, accounting for 55.70% of the overall permanent residents. Within the four years, number of permanent residents grows each year at the speed of 10 thou-

sand population; rural population decreases each year at the speed of 112 thousand. According to the average grain consumption per capita in the years 2004–2007, total annual food consumption of urban and rural areas in Hubei Province is 14138 thousand tons, among which, the annual grain consumption of rural residents is 8 912 thousand tons.

**Table 2 Population and grain consumption in Hubei Province in the years 2004 – 2007**

Year	Permanent residents $\times 10^4$	Rural population $\times 10^4$	Total grain consumption of rural population // $\times 10^4$ t	Total grain consumption in urban and rural areas // $\times 10^4$ t
2004	5 696	3 208.0	891.82	1 412.61
2005	5 710	3 243.3	901.64	1 416.08
2006	5 693	3 199.5	889.46	1 411.86
2007	5 699	3 174.3	882.46	1 413.35
Average	–	–	891.20	1 413.80

According to the calculation method by Chinese Academy of Agricultural Sciences, annual indirect grain consumption is about 7 492 thousand tons in Hubei Province in the years 2004 – 2007 (Table 3). The overall direct and indirect grain consumption of Hubei Province is about 21 620 thousand tons. Among them, direct and indirect grain consumption of rural residents is about 12 712 thousand tons and that of urban residents is about 8 908 thousand tons; and the direct and indirect grain consumption of urban residents is about 8 908 thousand tons.

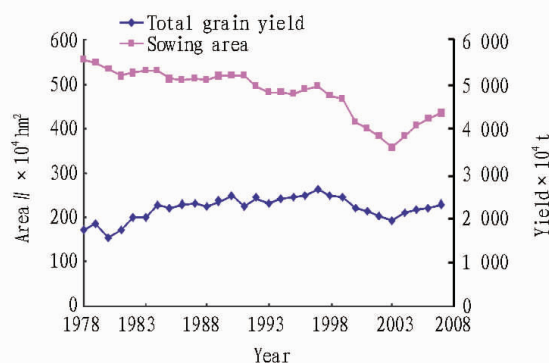
**Table 3 Average grain consumption in Hubei Province in the years 2004 – 2007**

Item	Grain consumption per capita	Indirect grain consumption	Total grain consumption
Rural residents	891.2	380.0	1 271.2
Urban residents	522.6	369.2	890.8
Total	1 413.8	749.2	2 162.0

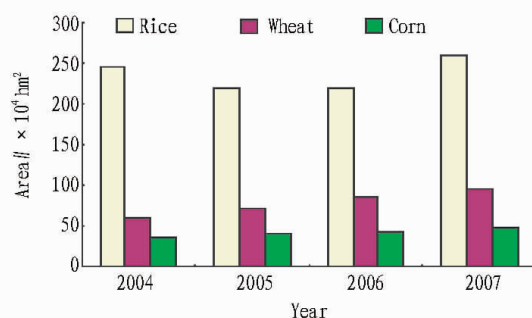
## 2.2 Grain production and consumption trend analysis of Hubei Province

**2.2.1 Grain production trend.** The main factors affecting the grain production level is the changes of sowing area and output. According to the change of grain sowing areas and outputs in Hubei Province since the year 1978, it can be concluded that the grain sowing area in the whole province shows a significant downward trend and the fluctuation of grain output is unstable. Grain sowing area reduces into less than 5 million hectares in the year 1992 and 4 million hectares in the year 2002. There are several causations for this. Firstly, during the adjustment of agricultural structure, diversified economy is implemented; proportion of the sowing area of economic crop has been gradually improved; and the sowing area of grain crops has been reduced. Secondly, since the price of agricultural production materials is raised, selling price of grain becomes relatively low for farmers. Thus, there are few profits for planting crops, which dampens the enthusiasm of farmers to grow grain. Thirdly, the young labor forces in rural areas usually work in cities in order to earn more. Therefore, the number of young labor forces engaged in agriculture decreases sharply. Since the year 2004, due to the implementation of grain subsidies, grain sowing area and yield gradually fall to the levels before the year 2000.

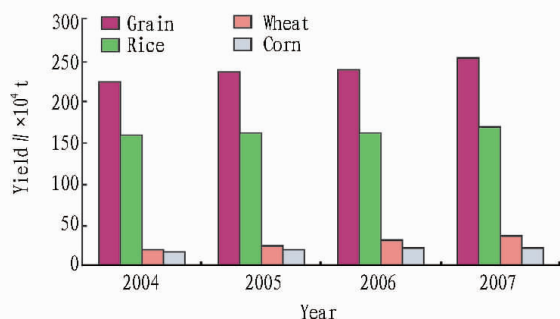
According to the grain production in the years 2004 – 2007, both the grain sowing area and the total output have been improved significantly. At the same time, structure of grain production has also been adjusted. In year 2007, total grain output is 25 340.7 thousand tons, increased by 2 922.9 thousand tons compared with year 2004 and an annual increase of 1 million tons. Among the major grain crops, proportions of rice sowing


**Fig. 1 Change curve of grain sowing area and grain yield in Hubei Province since the year 1978**

area and output in the total crop sowing area and output have been reduced from 64.24% and 71.19% in the year 2004 to 59.77% and 66.46% in the year 2007, respectively, a decrease of 4.5 and 4.7 percentage points. Proportions of wheat sowing area and output have increased from 15.81% and 9.64% in the year 2004 to 22.10% and 15.04% in 2007, respectively, an increase of 6.3 and 5.4 percentage points. Proportions of corn sowing area and output have increased from 9.61% and 8.09% in the year 2004 to 11.09% and 9.21% in 2007, respectively, an increase of 1.5 and 1.1 percentage points.


**Fig. 2 Changes of the sowing area of major grain crops in Hubei Province in the years 2004 – 2007**

According to the history of grain production in Hubei Province, the maximum output is more than 55 million tons. Therefore, there is still a relatively huge growth space for the grain output. With the implementation of high-yield varieties and the construction of agricultural infrastructure, grain unit yield will be further improved. Without considering the impact of the decrease of cultivated land, grain production will obtain stable improvement. According to the growth trend of grain in recent years, grain production in Hubei Province will increase at the



**Fig. 3** Changes of the total grain yield and the yield of major grain crops in Hubei Province in the years 2004 – 2007

speed of 1 million tons each year, will reach the goal of 30 million in the next five years, and will reach the production scale of 35 million tons of grain in the long term. At the same time, grain quality will obtain significant increase and grain production structure will be further optimized. Among the main food products, rice output will be further improved stably, especially the high-quality rice. Proportions of wheat and corn output in crop output will rise by 1.5 and 0.4 percentage point, respectively.

**2.2.2 Change trend of total grain consumption.** Main factors affecting the regional grain consumption is the living standard of residents and the urban-rural population structure. According to the international experiences, economic development and per capita income level have extremely close correlation with grain demand. Before reaching the high income level, growth rate of grain demand increases with the growth of income. And grain demand reaches its maximum value when the income is at the middle level. And the grain consumption structure enters into the fastest conversion stage. The most significant change is that among all the grain consumption, growth rate of people's demand for plant foods increases rapidly at first and then becomes slowly, while that for animal foods increases slowly at first and then becomes rapidly. This change indicates that the indirect consumption of grain will grow greatly when the per capita income enters into the middle income level.

According to the investigation data in counties and cities in Hubei Province in the year 2004-2007, grain consumption per capita has almost no correlation with the per capita net income of farmers. The regional difference of grain consumption per capita is mostly determined by the intensity of agricultural production and the food resources in different regions. However, income growth of urban and rural residents has brought along the significant change in consumption structure, which affects the grain consumption per capita of residents and the overall grain consumption significantly, and reduces the per capita grain direct consumption. If considering the meat, egg and milk consumption, total demand of per capita grain consumption increases in reality. According to the investigation data, grain consumption per capita decreases by 39 kilograms each year in Hubei Province within the years 2004 – 2007. Rural per capita ration reduces by 4 kilograms each year; and urban per capita ration decreases by 0.5 kilogram each year. According to the per capita meat consumption change in the years 2004 – 2007, per capita average meat consumption enhances by 2 kilograms

each year. If adopting the calculation method put forward by the Chinese Academy of Agricultural Sciences, we can conclude that per capita indirect grain consumption increases by 7.5 kilograms each year. And grain consumption of the urban and rural residents reduces by 664.7 thousand tons in the years 2004 – 2007. Among them, grain consumption of rural population decreases by 478.5 thousand tons. At the same time, affected by the increase of animal food consumption, per capita indirect grain consumption increases gradually. Compared with the year 2004, indirect grain consumption rises by 428 thousand tons in the year 2007, which counterweighs the reduction of direct grain consumption (665 thousand tons). Thus, the grain consumption of Hubei Province only reduces by less than 180 thousand tons.

According to the population growth and the socio-economic development in Hubei Province since the year 1995, population urbanization promotes rapidly; economic growth increases sharply; and the income level and consumption capacity of urban and rural residents are enhanced significantly. Total population in the year 2007 is 60 700 thousand. Among them, permanent population is 56 990 thousand, urban population is 26 890 thousand, and rural population is 33 810 thousand. Urbanization rate has increased from 28.0% in the year 1995 to 44.3% in 2007, an annual increase of 1.36 percentage points. Urban population increases by 10 730 thousand; while rural population decreases by 7 730 thousand. Calculated according to this rule, total grain consumption in urban and rural areas in Hubei Province has reduced by 1 980.7 thousand tons within the years 1995 – 2007. Among them, rural grain consumption reduces by 4 144.2 thousand tons; and urban grain consumption enhances by 2 163.5 thousand tons due to the increase of population.

In the next 10-15 years, residents in Hubei Province will gradually achieve the income level of medium-developed regions. Meanwhile, the rapid urbanization and agricultural industrialization will promote the transfer of rural labor forces and population into townships and secondary and tertiary industries. Therefore, consumption structures of both urban and rural residents will be changed greatly. In the next 5-10 years, urbanization level of Hubei Province will grow at the speed of 1% each year. GDP will have an annual average growth rate of 10%. Income of both urban and rural residents will be improved significantly. In the structural component of residents' consumption, direct grain consumption will decrease and maintain stable. But the indirect grain consumption will increase significantly. According to the change trend of residents' grain consumption and meat consumption in Hubei Province, it can be calculated that the annual grain consumption per capita will be 220 kilograms in the year 2020. Among them, grain consumption per capita of rural residents is 235 kilograms, per capita meat foods consumption is 50 kilograms, total grain consumption of Hubei Province is about 21 million tons, total grain consumption of rural residents is 11 million tons, and total grain consumption of urban residents is 10 million tons.

**2.3 Analysis on the grain supply-demand balance and the grain supply capacity in Hubei Province** Table 4 reports the grain supply-demand balance in Hubei Province based on

the current status and change trend of grain production and consumption. Taking the situation of 2007 as the current status, total grain output is 25 340.7 thousand tons, total grain demand is 21 620.0 thousand tons, and grain consumption of urban residents is 8 908.0 thousand tons. Thus, the grain supply-demand balance is 3 720.0 thousand tons currently. Since grain consumption of urban residents belongs to the commodity grain, commodity grain supply of Hubei Province is 11 628.0 thousand tons; and the commodity rate of grain production is 46.70%. However, there are great differences in the grain commodity rate in different counties and cities. Jingshan County has the highest rate of 88%; and more than 10 counties are even not self-supporting. For instance, Tongshan County needs at least 1/4 of the grain support. Counties (Cities) supply more than 200 thousand tons of commodity grain are Jianli County, Zengdu District, Zaoyang City, Zhongxiang City, Xiangyang District, Xiantao City, Jingshan County, Shayang County, Gongang County, Yicheng City, Tianmen City, Qianjiang City, Yingcheng City, Macheng City, Songzi City, Anlu City, Dangyang City, Jiangxia District, and Jiangling County. These 19 counties (cities) provide in all 6 680.1 thousand tons of commodity grain each year, accounting for 62.19% of the total commodity grain production in Hubei Province.

Table 4 Analysis of the grain supply and demand balance in Hubei Province

Year	Total grain output	Grain demand	Supply and demand balance
2007 (Current status)	2 534.07	2 162.00	372.00
2010( Short term)	3 200.00	2 150.00	1 050.00
2020( Long term)	3 500.00	2 100.00	1 400.00

Based on ensuring the stable increase of grain production, Hubei Province plans to achieve 10 million – 14 million tons of grain surplus in the long term ( the year 2020). Hubei Province determines the number of new grain reserves in the year 2004, which is 900 thousand tons, in order to ensure the grain consumption demand of non-agricultural population, adjust the grain supply-demand balance in Hubei Province, stabilize the

prices of grain market, and deal with major natural disasters or other emergencies. Therefore, Hubei Province can offer the state 9 400 thousand and 13 100 thousand tons of commodity grain in the short term and long term, respectively, which is a great contribution to the national grain security of China.

3 Conclusion and discussion

Hubei Province is one of the major provinces producing commodity grain in China, which plays an important role in ensuring the regional grain demand and commodity grain supply. Sowing area of grain fluctuates greatly due to the price rise of the means of agricultural production and the low price of grain market. Especially in the years 1997 – 2002, grain output decreases greatly in Hubei Province. However, under the guidance of a series of policies ensuring the stable grain production, it is still possible for the grain production of Hubei Province to return to the previous level in 1997, so as to make contribution to the national grain security. Besides, due to the impact of market mechanism and regional urbanization, there are still many unstable factors in regional grain production of China, such as the low net income of grain production, the decrease of cultivated land area, the loss of rural young labor forces, the lack of effective and long-term stimulating mechanisms for regional grain production.

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