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Analysis on Comparative Advantage in the Production of Major Grain Varieties in Different Areas of China

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Abstract: *This paper uses the location quotient index and relative growth rate to measure the comparative advantage in the production of rice, wheat, corn and soybeans in different provinces of China. The result shows that there exists great difference in the production of major grain varieties in different areas of China and that the northern areas are accumulating their competence. Because great changes have taken place in the space structure of the production of major grain varieties and water resources will constitute a rigid restraint in the production of grain, it will become the priorities in guaranteeing the Chinese future food safety to promote the nurturing of areas with advantage in the production of corn and soybeans, and it will become the key for guaranteeing the balance between the demand and supply of grain to enhance the development of grain circulation system.*

Keywords: Grain Variety structure Comparative advantage

1 Introduction

The production of grain is the core basis to guarantee food safety. It is one of the strategic measures to increase the capacity to produce enough grain for the whole country and guarantee the Chinese food safety to give full play to the comparative advantage of production of grain in different areas, pay attention to nurturing the areas with advantage in the production of grain and implement the non-balance

development strategy of providing preferential treatment for areas with advantage in the production of grain. Since 1980's, the Chinese central government have put a lot of emphasis on developing major grain producing areas, concentrative grain producing areas and agricultural products industry with comparative advantages to exert the comparative advantage of different areas in the production of grain and have carried out some significant projects, such as the excellent grain project, the grain harvest project and the project of large commercial grain base development. These measures have played a decisive role in promoting agricultural development and guaranteeing food safety. From 1978-2013, the aggregate grain output increased from 304.76 million tons to 601.93 million tons, and the grain output per capita rose from 316.6 kilos to 442.37 kilos in 2013, which displays that our country has leaped from the long-term shortage to the basic balance of demand and supply of grain. Generally speaking, the aggregate output has tended to influence the balance between demand and supply of grain less while the variety structure has exerted more influence since 1980's and has become the major problem in realizing the balance of demand and supply of grain in China^[1]. Meanwhile, the regional structure of grain production in China has experienced important changes-----The pattern of transporting grain produced in the southern parts to the northern parts has been reversed, the producing center of grain has gradually shifted to the northern parts and tended to concentrate on minority areas^[2]. So far, China has basically formed a regional structure of grain producing which centers on JinJiLuYu, northeast of China, coastal areas in southeast of China, the middle reaches of the Yangtze River, northwest, southwest and Beijing-Tianjin areas¹ (not including Hongkong, Macao and Taiwan, Figure 1). Some of the areas have already played a decisive role in the Chinese food safety. However, from the nationwide perspective, the basis for the long-term sustainable growth of

¹ In terms of the natural economic features and the grain production conditions in China, this paper categorizes the grain producing areas as the followings: northeast areas include Heilongjiang Province, Jilin Province and Liaoning Province; JinJiLuYu include Shanxi Province, Hebei Province, Shandong Province and Henan Province; coastal areas of Southeast China includes Shanghai, Jiangsu Province, Zhejiang Province, Fujian Province, Guangdong Province, and Hainan Province; the middle reaches of the Yangtze River includes Hubei Province, Hunan Province, Anhui Province and Jiangxi Province; the northwest areas include Shanxi Province, Gansu Province, Ningxia Hui Minorities Autonomous Region, Qinghai Province, Xinjiang and Inner Mongolia; the southwest areas include Chongqing Municipality, Sichuan Province, Guiyang Province, Yunnan Province, Tibet and Guangxi Zhuang Minorities Autonomous Region.

grain production is not solid, the structural and regional conflicts are becoming more prominent, the water and land resources are becoming an increasing constraint for grain production and the uncertainty from extreme climates and market fluctuation caused the risks of grain production to increase. According to “the Plan to Increase the Grain Output by 50 Billion Kilos”, Adapting to the Chinese regional structure of grain production and the new tendencies of grain variety structure and the demand and supply changes, Giving full play to the regional comparative advantage in the production of grain and making a scientific and reasonable arrangement to develop advantageous areas are of great significance for coordinating the relationship between demand and supply of grain in different areas and guaranteeing the national food safety.



Figure 1 Regional distribution of China's grain production

2 Reviews of the Chinese Producing Conditions of Major Grain Varieties

Rice has always been the largest variety in view of the production of rice, wheat, corn and soybeans and its output increased from 140 million tons from 1978 to 204 million tons in 2012, with an annual growth rate of 1.09 %; however, its proportion in the aggregate grain output fell from 44.93% in 1978 to 34.65% in 2012. Wheat had been the second largest variety in China before the middle period of 1990's, and its output rose from 54 million in 1978 to 120 million tons in 2012, with an annual growth rate of 2.4%, its proportion in the aggregate grain output increasing from 17.67% in 1978 to 20.45% in 2012. Corn is the fastest growing variety in China. Its output surpassed that of wheat after the middle period of 1990's and became the second largest grain variety. From 1978 to 2012, the output of corn rose from 56 million to 208 million tons, with an annual growth rate of 3.57%, its proportion in the aggregate grain output increasing from 18.36% to 35.30% in 2012. The output of soybeans rose from 7.46 million tons to 12.8 million tons in 2012, with an annual growth rate of 3.26%, its proportion increasing from 2.48% to 2.17% in 2012. The Changes in the proportion of four varieties of grain in the aggregate grain output are illustrated as Figure 2.

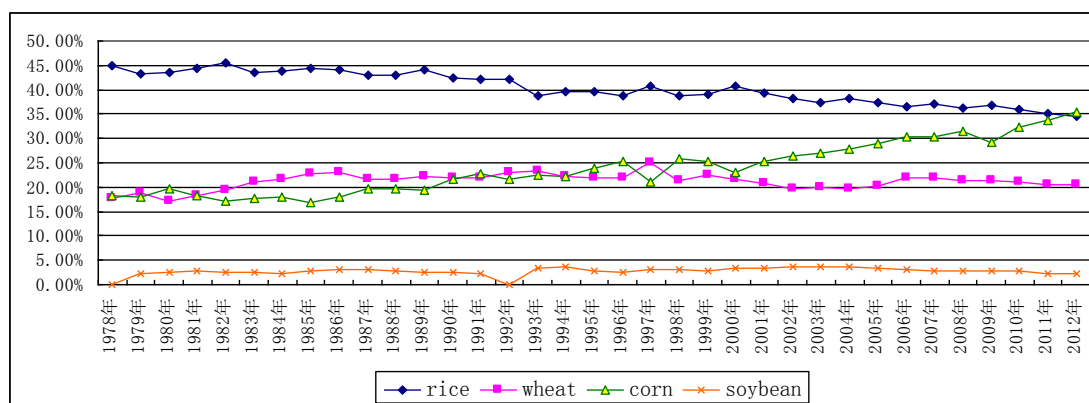


Figure 2 The Changes in the proportion of four varieties of grain in the aggregate grain output from 1978-2012

Source: Department of Rural Social and Economic Survey of National Bureau of Statistics of China: 2013 China Rural Statistical Yearbook, China Statistical Press, 2013.

In terms of the producing areas, the grain production mainly centers on the middle reaches of the Yangtze River and the coastal areas of Southeast China, but the

grain output in the two areas tended to decrease year by year. In 1978, the rice output and sowing area in the two areas accounted for 70.91% and 71.38% of the national grain output and the national sowing area. Nevertheless, the two figures fell to 54.89% and 59.90% in 2011. At the same time, the rice output and sowing area increased by a significant scale and the proportions in the national grain output and sowing area rose from 2.95% and 2.57% in 1978 to 15.87% and 14.92% in 2011 respectively. The production of wheat focuses on JinJiLuYu areas and the output and sowing area tend to expand, the proportions in the national grain output and sowing area increasing 45.36% and 40.12% in 1978 to 57.44% and 49.54% in 2011. The proportions of the wheat output and sowing area in the middle reaches of the Yangtze River in the national grain output and sowing area rose a little while the proportions of the wheat output and sowing area in northeast, northwest and southwest in the national grain output and sowing area fell by a large scale. The production of corn mainly concentrates on JinJiLuYu area and northeast area, the proportions of its output and sowing area changed a little. The proportions of the corn output and sowing area in southwest area decreased by a relatively large degree while the corn output increased a lot from 9.88% and 10.41% in 1978 to 17.19% and 16.89% in 2011. The production of soybeans mainly focuses on the northeast area and grows very fast. The proportions of the soybean output and sowing area in this area increased a lot from 43.27% and 38.25% in 1990 to 37.52% and 37.65% in 2011. The proportions of the soybean output and sowing area in the middle reaches of the Yangtze River and the northwest area increased to some extent and the proportions of the soybean output and sowing area in JinJiLuYu area decreased by a significant scale. See Table 1.

3 Research Methods and Data Source

3.1 Research Methods

Comparative advantage in the production of agricultural products is the fundamental basis for the rearrangement of production location of grain varieties in different areas ^[3]. The major methods to measure whether a country or region has comparative advantage in the production of a good includes Comparative Advantage Index (CAI), Domestic Resource Cost Coefficient (DRCC), and Rate Analysis (RA). Regardless of any method used, an agricultural product which has been found after measurement to have comparative advantage should be characterized with the followings: ① big production scale, high specialization and sound basis for future

development; ② fast growth rate and high growth potentials;③ resource endowments, technical conditions and production scale which can satisfy the needs for sustainable development of this product.

This paper mainly uses Location Quotient (LQ) to measure comparative advantage

in the production of major grain varieties in different areas in addition to Relative Growth Rate Index(RGRI).

3.1.1 Location Quotient (LQ). Location Quotient was used first to reflect the specialization level of a specified industrial sector in a region relative to that in the whole country and often used to analyze comparative advantage in different industries of different areas and help select the leading industry. As far as the calculation of Location Quotient is concerned, economists often use such measurements as output, output value, sales revenue and quantity of employment. This paper utilizes output and sowing area of four major varieties of grain to calculate the output location quotient and the sowing area location quotient of rice, wheat, corn and soybeans in 7 major grain producing areas in 31 provinces (municipalities and autonomous regions). Suppose LQ_{ij} for the location quotient of Industry j in Area i , then the calculation of LQ_{ij} can be expressed as

$$LQ_{ij} = \frac{L_{ij} / \sum_j L_{ij}}{\sum_i L_{ij} / \sum_i \sum_j L_{ij}} = \frac{L_{ij}}{\sum_i L_{ij}} \frac{\sum_i \sum_j L_{ij}}{\sum_j L_{ij}} \quad (1)$$

In the equation (1), i for Area i , j for Industry j (grain variety) and L_{ij} for output or sowing area in Industry j (grain variety) of Area i . When $LQ_{ij} > 1$, it shows that Area i has a relatively high concentration in Industry j (grain variety). The larger LQ_{ij} is, the higher specialization of the production of grain variety j in Area i . When $LQ_{ij} < 1$, it is thought that Area i has a relatively low specialization in Industry j (grain variety). The smaller LQ_{ij} is, the lower specialization of the production of grain variety j in Area i .

3.1.2 Relative Growth Rate. Because Location Quotient can only displays the concentration degree or specialization level of the production of one industry (grain variety) in one area and can't be able to show comparative advantage of one area in the production of one industry (grain variety), this paper adopts Relative Growth Rate, that is, the ratio between the growth rate of output and sowing area of one industry (grain variety) in one area and that in the whole country. The calculation of Relative

Growth Rate (for convenience, expressed as λ in this paper) is as follows.

$$\lambda = \frac{t \sqrt{\frac{a_1}{a_0}} - 1}{t \sqrt{\frac{A_1}{A_0}} - 1} \quad (2)$$

In the equation (2), t for time, a_0 and a_1 for output of one grain variety in certain area(province, municipality and autonomous region) in the base period and in the report period and A_0 and A_1 for aggregate output of that grain variety in the whole country in the base period and in the report period. If $\lambda > 1$, it shows that the growth rate of the production of that grain variety in the reported area is faster than that in the whole country. The larger λ is, the faster the production of the grain variety grows. On the contrary, If $\lambda < 1$, it shows that the growth rate of the production of that grain variety in the reported area is slower than that in the whole country. The smaller λ is, the more slowly the production of the grain variety grows.

3.2 Data Source

The major grain varieties mainly include rice, wheat, corn and soybeans; therefore, this paper adopts the data as regards output and sowing area of four major varieties of grain in 31 provinces (municipalities and autonomous regions) in 1978-2011 from the New China 60 Years Rural statistics, The China statistical Yearbooks, The China Rural Yearbooks and The China Agricultural Yearbooks.

4. Data Analysis

According to the data in Table 1, this paper uses Equation (1) to calculate the grain output location quotient and the grain sowing area location quotient in 31 provinces(municipalities and autonomous regions) and the results are illustrated in Table 2. Then the paper adopts 1990 as the base year and 2011 as the report year and uses Equation (2) to calculate the relative growth rate of grain output and the relative growth rate of grain sowing area in 31 provinces (municipalities and autonomous regions).Because of the reduction of sowing area and the rearrangement of sowing structure, the sowing area of rice and wheat in 2011 decreased compared with that in 1990 and the relative growth rate of sowing area of rice and wheat in the whole country is negative. In order to avoid the data deviation, when calculating the relative growth rate of sowing area of rice and wheat in the whole country in 2011, this paper replaces the denominator $\left| \sqrt[t]{\frac{A_1}{A_0}} - 1 \right|$ with $\sqrt[t]{\frac{A_1}{A_0}} - 1$. Therefore, as far as the relative growth rate of sowing area of rice and wheat is concerned, when $\lambda < -1$, it

shows that the reduction rate in the reported area is faster than that in the whole country; when $-1 < \lambda < 0$, it shows that the reduction rate in the reported area is slower than that in the whole country; when $\lambda > 0$, it shows that the growth rate in the reported area is faster than that in the whole country. As far as corn and soybeans are concerned, only when $\lambda > 1$, does the growth rate of sowing area become faster than that in the whole country. For calculating results, see Table 3.

The followings can be seen in accordance with the results in Tables 2 and 3:

(1)Rice

Both the output LQ and sowing area LQ are larger than 1 in the middle reaches of the Yangtze River, coastal areas of Southeast China and Southwest. The growth rate of rice output is larger than 1 in northeast, Henan and Shandong of JinJiluYu, Jiangxi, Hunan and Anhui of the middle reaches of the Yangtze River, the Inner Mongolia, Gansu and Ningxia of northwest and Tibet, Guizhou and Yunnan of southwest. The relative growth rate of rice sowing area is larger than 0 in northeast, Henan and Shandong of JinJiluYu, the Inner Mongolia, Gansu and Ningxia of northwest and Tibet of southwest.

As the first largest rice production concentrating area, the middle reaches of the Yangtze River have the highest specialization. In 2011, rice output and sowing area accounted for 33.21% and 38.76% respectively in the whole country, the output LQ and sowing area LQ reached 1.6695 and 2.2239 respectively, the relative growth rate of rice output was minus .9965, and the relative growth rate of sowing area was minus .8312, which show that the increase in the unit output per hectare in this area made up for the output loss caused by the reduction of sowing area.

As the traditional second largest rice production concentrating area, the coastal area of Southeast China is gradually losing its comparative advantage in the production of rice. In 2011, the rice output and sowing area in this area accounted for 21.68% and 21.14% respectively in the whole country, which are lower than those in Southwest, and fell by 12.57 and 12.34 percent points from 1978. The output LQ and sowing area LQ reached 1.7820 and 2.1353 respectively, which displays that this area has relatively high specialization in the production of rice. The relative growth rate of rice output and the relative growth rate of sowing area were minus 4.6263 and minus 4.9117. The sharp reduction of output and sowing area has greatly influence the development potentials of rice production in this area.

Rice output and sowing area in southwest accounted for 20.29% and 21.72%

respectively in the whole country in 2011, which made this area become the second largest rice producing area. The output LQ and sowing area LQ reached 1.2630 and 1.2428 respectively, which shows the high specialization in the production of rice in this area. The relative growth rate of rice output and the relative growth rate of sowing area were minus 0.7884 and minus 1.3625, mainly because of the significant reduction in rice output and sowing area in Sichuan Province. From 1978 to 2011, the rice output and sowing area in Sichuan Province fell from the first placement to the fifth placement in China. Nevertheless, the increase of rice output in Yunnan, Guizhou, and Tibet made up for the reduction of rice output in Sichuan. Meanwhile, the regional comparative advantage in the production of rice in southwest has been affected to a remarkable extent owing to the relatively vulnerable ecologic conditions and the effect of extreme climates.

The rice output LQ and sowing area LQ in northeast were 0.7788 and 0.8224 respectively while the relative growth rate of output and sowing area reached 20.4003 and 10.3898, which made this area the fastest growing area of rice production. In 2011, unit output per square hectometer reached 7605.33kg, 15.88% higher than the national unit output of 6563.00 kg. The rice produced in this area has high quality, great taste and big market demand, showing the outstanding regional comparative advantage and high development potentials. In addition, Henan and Shandong of JinJiLuYu, the Inner Mongolia, Gansu and Ningxia of northwest have witnessed a fast growth momentum in rice output and sowing area. Because northwest and JinJiLuYu have relatively abundant cultivating land beneficial for economy of scale, specialization and mechanization of rice production, these two areas have late-mover advantages.

Generally speaking, the middle reaches of the Yangtze River and coastal area of Southeast China are still the traditional advantageous areas in the production of rice; however, the regional comparative advantage in the two areas has decreased to some extent. Such northern producing areas as northeast, northwest and JinJiLuYu are enhancing their regional comparative advantage in the production of rice.

(2) Wheat

Both the output LQ and sowing area LQ are larger than 1 in JinJiluYu, Beijing-Tianjin, northwest, Anhui from the middle reaches of the Yangtze River, and Jiangsu from coastal area of Southeast China. The growth rate of wheat output is larger than 1 in Henan, Hebei and Shandong of JinJiluYu, Anhui from the middle

reaches of the Yangtze River, and Tibet of southwest. The relative growth rate of wheat sowing area is larger than 0 only in Henan of JinJiluYu and Anhui from the middle reaches of the Yangtze River.

JinJiluYu shows outstanding regional comparative advantage in the production of wheat. In 2011, the wheat output and sowing area in this area accounted for 57.44% and 49.54% respectively in the whole country. The output LQ and sowing area LQ reached 2.1185 and 2.0608 respectively. The relative growth rate of output and sowing area were 2.2822 and minus .1496. However, the wheat output and sowing area in Shanxi has reduced by a remarkable scale and only Henan, Shandong and Hebei display strong growth momentum in the production of wheat.

JinJin shows high specialization in the production of wheat because in 2011, the wheat output LQ and sowing area LQ reached 1.3117 and 1.4924 respectively and the unit output per hectometer is spectacularly higher than that in other areas. Nonetheless, the output decreased by a large scale because of reduction in cultivating land and grain sowing area caused by urbanization. The calculating results show that the relative growth rate of output and sowing area were - 3.7523 and -2.7475, remarkably lower than those in other areas, which means that Beijing-Tianjin has no longer enjoyed regional comparative advantage in the production of wheat.

Northwest is one of the advantageous areas in producing high quality strong gluten and middle gluten wheat. In 2011, the wheat output LQ and sowing area LQ reached 1.0781 and 1.2204 respectively, which shows high specialization in the production of wheat in this area. The relative growth rate of output and sowing area were -0.4607 and -1.7718. The outstanding problems existing in this area include drought and little rainfall, vulnerable ecologic conditions, backward agricultural infrastructures and lower unit output per square hectometer than the national unit output. Fortunately, this area has relatively abundant cultivating land, plenty of sunlight, and sharp difference between day and night temperatures, which make this area suitable for developing high quality strong gluten and middle gluten wheat .Therefore, this area has relatively strong late-mover advantage in the production of wheat.

In addition, Anhui in the middle reaches of the Yangtze River has advantage in the specialized production of wheat and relative growth rate while in coastal area of Southeast China, southwest and northeast, the wheat sowing area declined and the output also tended to decrease because of the deepening structure reform brought

about by quality and market constraints. The production of wheat in these areas is withering. In particular, the wheat sowing area in southwest declined by more than 1 million hectares and the output fell by more than 2 million tons in 2011. The wheat sowing area in northeast declined by 1.7 million hectares and the output fell by more than 4 million tons in 2011 compared with those in 1990, which made this area suffer the worst reduction in the wheat sowing area and output.

Generally speaking, compared with the production of rice, the production of wheat is dispersed relatively widely and there are fewer advantageous producing areas. Except Henan, Hebei and Shandong in JinJiLuYu and Anhui in the middle reaches of the Yangtze River all other provinces (municipalities and autonomous regions) have comparative disadvantage in the production of wheat.

(3) Corn

Both the corn output LQ and sowing area LQ are larger than 1 in northwest, Beijing-Tianjin, Shanxi, Hebei, and Shandong in JinJiLuYu, the Inner Mongolia, Xinjiang, Ningxia and Shanxi in northwest and Yunnan in southwest. The growth rate of corn output is larger than 1 in the middle reaches of the Yangtze River, Shanxi and Hebei in JinJiLuYu, the Inner Mongolia, Xinjiang, Ningxia and Shanxi in northwest, Tibet, Guizhou, Yunnan and Guangxi in southwest and Heilongjiang in northeast. The relative growth rate of corn sowing area is larger than 1 in Shanxi in JinJiLuYu, Guangdong and Fujian in coastal area of Southeast China, Hunan and Anhui in the middle reaches of the Yangtze River, the Inner Mongolia, Ningxia and Gansu in northwest and Heilongjiang in northeast.

China is a large corn producing and consuming nation, whose aggregate corn output is only lower than that of USA. Corn has become the second largest grain variety and corn output and sowing area have risen by a relatively large scale since the middle period of 1990s. The production location of corn is dispersed relatively widely while northeast and JinJiLuYu accounted for 54.03% and 61.34% in the national corn output and sowing area in 2011. The corn output LQ and sowing area LQ reached 1.6223 and 1.6907 respectively and the relative growth rate of output and sowing area were 0.9394 and 1.2006 in northeast. The corn output LQ and sowing area LQ reached 1.1804 and 1.3275 respectively and the relative growth rate of output and sowing area were 0.9497 and 0.8627 in JinJiLuYu. The two areas are areas with relatively high specialization in the production of corn and relatively fast growth rate. From the nationwide perspective, the two areas are corn production concentrating

areas with relatively strong comparative advantage.

In 2011, the corn output LQ and sowing area LQ in Beijing-Tianjin reached 1.7861 and 1.9613 respectively, which showed that this area enjoys the highest specialization in the production of corn. However, the relative growth rate of corn output and sowing area were -0.1479 and -0.4793 in this area, mainly caused by the sharp reduction in sowing area, which meant limited development potentials in the production of corn. In 2011, the corn output LQ and sowing area LQ in northwest reached 1.4462 and 1.2698 respectively and the relative growth rate of corn output and sowing area were 1.6421 and 1.7321. Northwest has made the largest contribution to the increase of national corn sowing area and become the third largest corn producing area in China.

In addition, southwest is an advantageous livestock breeding area and has great demand for corn. The production of corn grew very fast under the drive of animal husbandry and the sowing area increased from nearly 4 million hectares in 1990 to more than 4 million hectares in 2011, making this area another important corn producing area. Nevertheless, a large amount of hilly and un-irrigated farmland, poor land, extensive cultivation and backward irrigating equipment make this area a typical rain-fed agricultural area with remarkable seasonal drought, low and unstable unit output and high potentials in the expansion of aggregate output. With the development of tourist industry and agricultural products exporting industry, fresh corn as a characteristic industry grew quite fast in Guangdong and Fujian in coastal area of Southeast China. The two provinces have increased fresh corn sowing area by a remarkably scale and become the major sweet corn producing areas.

Generally speaking, such northern areas as northeast, JinJiLuYu and northwest have strong regional comparative advantage in the production of corn. Guangdong and Fujian in coastal area of Southeast China have regional comparative advantage in the production of fresh sweet corn and Yunnan and Guizhou in southwest have relatively high potentials in expanding sowing area and increasing aggregate output. Other areas have no longer had regional comparative advantage in the production of corn.

(4) Soybeans

According to the calculating results in Tables 2 and 3, the soybean output LQ and sowing area LQ were larger than 1 only in Heilongjiang in northeast, the Inner Mongolia in northwest and Anhui in the middle reaches of the Yangtze River. These

areas also experienced relatively fast growth in soybean output and sowing area, which showed that Heilongjiang, the Inner Mongolia and Anhui have relatively outstanding comparative advantage in the production of soybeans. Xinjiang and Gansu in northwest and Yunnan in southwest also witnessed relatively fast growth in soybean output and sowing area and these areas are enhancing their regional comparative advantage in the production of soybeans. Generally speaking, China only has a few advantageous areas in the production of soybeans, both the soybean output and sowing area are declining, and the production of soybeans and even the whole soybean industry are facing an increasingly grim situation.

Soybeans are the most important oil bearing crops in the world and the major source for quality protein and oil. Soybeans are also the first largest imported agricultural products in China. In recent years, the whole soybean industry in our country is facing an increasingly grim situation----only a few advantageous soybeans producing areas, frequent fluctuation in the production of soybeans and increasing consumption year by year. According to the data issued by the United States Department of Agriculture (USDA), the consumption of soybeans in China was 15.5 million tons in 1997. This figure became nearly 75 million tons in 2012, an increase by 4.8 times, and an annual growth rate of 11.1%. On the contrary, soybean output declined other than increased, from nearly 14.7 million tons in 1997 to 12.77 million tons in 2012. The annual growth rate from 1978 to 2012 was only 1.6%. There is a large gap between supply and demand of soybeans. In recent years our country has had to import soybeans to satisfy huge demand in the domestic market and the degree of dependence on foreign imports of soybeans reached 70%.By this token, if China wants to satisfy the Chinese demand for soybeans by increasing the production of soybeans, the annual growth rate of the production of soybeans should be kept at 12%, which is difficult to realize according to the production conditions of soybeans in the past 30 years. Therefore, the situation that the gap between supply and demand must be filled up through imports of soybeans will last for a relatively long period.

As far as the changes in the production of four major varieties of grain in different areas of China are concerned, coastal area of Southeast China and the middle reaches of the Yangtze River still play a leading role in the production of rice and the regional comparative advantage in the production of rice is being transferred to northeast and northwest. The production of wheat declined in northeast, northwest and southwest while at the same time being focused on JinJiLuYu and the middle

reaches of the Yangtze River, among which JinJiLuYu has accounted for a half of the national wheat output, showing this area enjoys remarkably comparative advantage in the production of wheat. While southwest reduced the production of corn, northeast and JinJiLuYu are gathering it up and northwest is expanding its production. The production of soybeans declined by a sharp degree in JinJiLuYu and is being focused on northeast and northwest. Southwest is expanding its production of soybeans. These changes show that comparative advantage in the production of four major varieties of grain in China ----rice, wheat, corn and soybeans---- is gradually moving towards northern producing areas.

5. Conclusions

Fundamental changes have taken place in the space structure of the production of grain in China after several large-scale agricultural structure reforms since the reform and opening-up policy. The production of major grain varieties used to be dispersed but now it is being concentrated. Comparative advantage in the production of grain is gradually coming into being in different areas and specialization in the production of grain is being enhanced. However, there still exist contradicts in regional structure and variety structure concerning the production of grain in China on the whole. The constraining factors are exerting an increasing influence upon the production of grain and should be taken into serious consideration.

5.1 It will become the first priority in guaranteeing the Chinese grain safety in the future to facilitate the development of advantageous corn and soybean producing areas. As far as the demand and supply conditions of major grain varieties at the moment in China are concerned, the supply of rice and wheat can basically meet and even to some degree exceed demand while the supply of corn and soybeans are significantly less than demand ^[4].The consumption of corn and soybeans will be increased further with the bettering of the Chinese food structure and the development of grain and oil processing industry. Nonetheless, the advantageous corn and soybean producing areas in China are declining and the constraining factors are increasing. In particular, the soybean output and sowing area are declining by a large scale, causing a spectacular supply shortage. Reducing the sowing area of rice and wheat to an appropriate extent and putting great emphasis on increasing the unit output of rice and wheat, facilitating the development of advantageous corn and soybean producing areas, expanding the sowing area of corn and soybeans, and promoting the popularization and application of production technologies of corn and soybeans to

increase the unit output of corn and soybeans during the restructuring process of agricultural production are the essential and vital measures to guarantee the balance of supply and demand of corn and soybeans and even the Chinese food safety from the mid-term and long-term perspective.

5.2 Water resources will become the hard constraint for the production of grain in China. Cultivating land is relatively abundant in northern regions but water is scarce. Although the gradual movement of comparative advantage in the production of major varieties of grain towards northern producing areas can be productive to realizing the scale of economy of land in the production of grain and can guarantee the basic balance of aggregate supply and demand of grain in China on a short-term basis, the fast development of urbanization and the tendency of rigid decline of cultivating land will become inevitable, which, plus seriously scarce water resources in northern producing areas and extremely backward irrigation infrastructures, will to significant degree restrict the increase of the comprehensive capacity of the production of grain in China. It can be seen that the shortage of water resources will surpass that of cultivating land to become the first constraining factor in the production of grain in China. Great attention should be paid to the constraint of water resources in the rearrangement of the production location of grain in the future ^[5]. At the same time, great efforts should be made to enhance the development of such infrastructures as farmland and irrigation, especially the improvement of irrigation infrastructures in northwest and northeast, to actively develop agricultural products which are water-efficient and can be grown in drought-stricken areas, to expand the sowing area which can be effectively irrigated, and to increase the ability to make drainage and fight against drought to raise efficiency with which water is utilized in the production of grain and guarantee the stable growth of the output of grain in China.

5.3 Promoting the construction of grain circulation system is the key to guarantee the balance of supply and demand of grain in China. The coordination of the relationship between demand and supply of grain in different producing and consuming areas not only relies on the increase of the guaranteeing capacity of grain production, but also the increase of the guaranteeing capacity of grain circulation. The changes in the space structure of advantageous producing areas of major grain varieties in China have posed heavy pressure on the Chinese grain circulation. At present, the producing and consuming areas of major grain varieties such as rice, wheat, corn and soybeans are seriously misallocated ^[5]. For example, the

advantageous producing areas of corn mainly concentrate on northeast and JinJiLuYu while the major corn consuming areas center on the southern parts in which animal husbandry-intensive areas are located and feed industries are developed. The rice consuming areas mainly focus on southern areas while the comparative advantage in the production of rice is expanding towards northeast and northwest. Such a production and consumption pattern of grain increases the difficulty to coordinate the balance between supply and demand of major grain varieties in different areas and in different seasons, and the balance of supply and demand of different grain varieties. In case of any emergency such as earthquakes, flood, extreme climate catastrophes and outbreaks of large-scale epidemic disease, if grain cannot be transported from producing areas to consuming areas on time, serious food shortage will be caused in the emergency-hit area within quite a short period, which may even trigger a food safety crisis and the social stability crisis. Therefore, while the production of grain is being concentrated on advantageous producing areas, great efforts should be made to promote the construction of the domestic grain circulation system and the development of grain logistics infrastructures to enhance the grain circulation security and to restructure the pattern of grain processing industries at the same time.

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Appendixes :

Table 1 the changes in the structure of major grain varieties in different areas from 1978 to 2011

		Output proportion (%)				Sowing area proportion (%)			
		1978	1990	2000	2011	1978	1990	2000	2011
JinJiLuYu	rice	2.30	2.42	2.65	3.18	2.05	2.18	2.62	2.82
	wheat	45.36	45.80	55.39	57.44	40.12	40.50	45.93	49.54
	corn	33.40	33.11	36.72	32.00	34.31	33.92	34.21	31.91
	soybeans		22.30	20.72	10.41		23.06	18.47	11.01
Coastal area of Southeast China	rice	34.25	30.42	27.33	21.68	33.48	30.83	26.82	21.14
	wheat	9.98	11.09	8.94	9.16	8.23	9.78	8.41	9.26
	corn	2.90	2.75	3.33	1.81	3.14	2.85	3.14	2.05
	soybeans		7.65	8.97	8.19		6.98	6.41	5.91
the middle reaches of the Yangtze River	rice	36.66	37.42	35.14	33.21	37.90	38.14	36.58	38.76
	wheat	10.31	10.45	9.76	13.40	11.27	12.04	11.79	14.21
	corn	2.93	3.06	5.37	4.35	3.97	4.37	5.26	5.13
	soybeans		10.97	13.37	11.75		13.32	13.60	13.94
Beijing-Tianjin	rice	0.26	0.26	0.13	0.05	0.25	0.24	0.17	0.05
	wheat	2.10	1.66	1.27	0.70	1.38	1.07	0.91	0.70
	corn	1.64	2.12	0.94	0.96	1.75	1.80	1.16	0.92
	soybeans		0.85	0.56	0.15		0.75	0.61	0.18
Northwest	rice	1.02	1.22	1.57	1.46	0.94	1.17	1.42	1.22
	wheat	15.25	16.63	13.89	19.40	19.40	19.53	17.42	16.24
	corn	9.88	11.17	15.14	17.19	10.41	12.23	14.47	16.89
	soybeans		8.18	9.20	15.28		9.29	13.27	15.05
Southwest	rice	22.56	22.58	23.63	20.29	22.81	22.49	23.45	21.72
	wheat	11.07	8.94	9.26	5.56	11.72	10.72	12.59	8.79
	corn	16.95	13.33	16.47	10.62	19.54	17.94	18.25	13.70
	soybeans		6.78	7.05	16.70		8.34	7.79	16.24
Northeast	rice	2.95	5.14	9.55	15.87	2.57	4.95	8.95	14.29
	wheat	5.93	5.42	1.48	0.93	7.89	6.36	2.95	1.27
	corn	32.28	34.46	22.03	33.07	26.87	26.88	23.51	29.38
	soybeans		43.27	40.14	37.52		38.25	39.77	37.67

Source: calculated according to the New China 60 Years Rural statistics.

Table 2 the grain output location quotient and the grain sowing area location quotient in 31 provinces (municipalities and autonomous regions)

Area	provinces (municipalities and autonomous regions)	grain output LQ				sowing area LQ			
		rice	Wheat	corn	soybeans	rice	Wheat	corn	soybeans
JinJiLuYu	Shandong	0.0618	2.1406	1.2260	0.2710	0.0641	2.2911	1.3821	0.2415
	Henan	0.2252	2.5375	0.8395	0.4759	0.2380	2.4597	1.0114	0.5327
	Hebei	0.0499	1.8114	1.4173	0.3117	0.0486	1.7366	1.5920	0.2961
	Shanxi	0.0011	0.9071	1.9646	0.5666	0.0011	0.9840	1.6510	1.0145
	Total	0.1173	2.1185	1.1804	0.3838	0.1172	2.0608	1.3275	0.4580
Coastal area of southeast China	Jiangsu	1.4824	1.3930	0.1875	0.6935	1.5551	1.8093	0.2568	0.6501
	Shanghai	1.9167	0.8896	0.0629	0.3406	2.0951	1.4624	0.0743	0.3455
	Zhejiang	2.1841	0.1556	0.0512	1.1201	2.6248	0.2637	0.0812	1.0298
	Fujian	2.0099	0.0054	0.0677	0.8194	2.5348	0.0104	0.1145	0.6821
	Guangdong	2.1200	0.0007	0.1590	0.3705	2.8217	0.0018	0.2255	0.3167
	Hainan	2.0301	0.0000	0.1503	0.3389	2.7219	0.0000	0.1799	0.2049
Total	1.7820	0.7527	0.1490	0.6731	2.1353	0.9358	0.2074	0.5974	
the Middle Reaches of the Yangtze River	Hubei	1.7806	0.6501	0.3171	0.4582	1.8172	1.1203	0.4396	0.4803
	Hunan	2.3046	0.0156	0.1759	0.3874	3.0656	0.0377	0.2210	0.3644
	Anhui	1.1636	1.7461	0.3172	1.0161	1.2394	1.6396	0.4076	1.5192
	Jiangxi	1.4032	0.0048	0.0140	0.3873	3.3438	0.0136	0.0232	0.4386
	Total	1.6695	0.6736	0.2185	0.5909	2.2239	0.8150	0.2944	0.8000
Beijing -Tianjin	Beijing	0.0043	1.0501	2.0333	0.2729	0.0035	1.2641	2.2119	0.3123
	Tianjin	0.1739	1.5086	1.6001	0.2911	0.1681	1.6462	1.7925	0.4276
	Total	0.1011	1.3117	1.7861	0.2833	0.1018	1.4924	1.9613	0.3812
Northwest	Ningxia	0.5187	0.7903	1.3170	0.3627	0.3621	1.0802	0.8938	0.4738
	Xinjiang	0.1302	2.1203	1.1593	0.6583	0.1268	2.3987	1.1721	0.4274
	Qinghai	0.0000	1.5418	0.4032	1.9023	0.0000	1.5328	0.2419	1.2001
	Gansu	0.0000	1.0986	1.1504	0.9502	0.0000	1.3853	0.9757	0.7312
	Shanxi	0.1860	1.5489	1.2642	1.0342	0.1419	1.6520	1.2385	0.7461
	Inner Mongolia	0.0858	0.3224	1.8748	1.9877	0.0595	0.4652	1.5824	1.9087
Total	0.1230	1.0781	1.4462	1.2856	0.0914	1.2204	1.2698	1.1313	
Southwest	Sichuan	1.2203	0.5965	0.5846	0.8097	1.1469	0.8908	0.6977	0.7110
	Guizhou	0.9116	0.2588	0.7622	0.6951	0.8205	0.3841	0.8499	1.0668
	Yunnan	1.0510	0.2661	0.9803	2.0808	0.9127	0.4611	1.0735	1.3786
	Chongqing	1.1519	0.1694	0.6255	1.0694	1.1178	0.2791	0.6812	1.0320
	Tibet	0.0168	1.1968	0.0820	0.7096	0.0216	1.0065	0.0813	0.3965
	Guangxi	1.9943	0.0006	0.4693	0.5599	2.4884	0.0022	0.6071	0.5703
	Total	1.2630	0.3462	0.6614	1.0397	1.2428	0.5027	0.7841	0.9291
Northeast	Heilongjiang	0.9737	0.0839	1.3174	2.8736	0.9420	0.1179	1.3147	3.0565
	Jilin	0.5172	0.0018	2.0230	0.8850	0.5595	0.0032	2.2732	1.1007
	Liaoning	0.6527	0.0082	1.8328	0.5036	0.7655	0.0099	2.2200	0.4697
	Total	0.7788	0.0455	1.6223	1.8409	0.8224	0.0730	1.6907	2.1673

Table 3 the relative growth rate of grain output and the relative growth rate of grain sowing area in 31 provinces (municipalities and autonomous regions)

area	provinces (municipalities and autonomous regions)	Grain output λ				Sowing area λ			
		rice	wheat	corn	soybean	rice	wheat	corn	soybean
JinJiLuYu	Shandong	2.3106	1.4966	0.8360	-1.1747	0.0254	-0.6066	0.4861	-2.8042
	Henan	9.5416	3.6535	0.8236	0.1679	3.9520	0.4560	0.7301	-0.6747
	Hebei	-6.9389	1.7945	0.9897	-0.7177	-5.9749	-0.1942	0.8827	-2.3017
	Shanxi	-37.5617	-1.5769	1.5063	-0.3801	-22.1335	-1.5091	2.1399	0.7077
	Total	5.6250	2.2822	0.9497	-0.4430	1.6989	-0.1496	0.8627	-1.1363
Coastal area of southeast China	Jiangsu	1.4592	0.5728	-0.0250	1.1042	-0.9189	-0.5391	-0.2346	0.8992
	Shanghai	-11.3387	-1.0483	-1.2206	0.4019	-8.9627	-1.0728	-1.9741	0.4372
	Zhejiang	-11.6727	-6.3686	0.5600	1.8714	-10.0603	-6.0549	-0.9597	1.8407
	Fujian	-5.8326	-18.2168	2.3985	1.0439	-6.0270	-14.7262	1.7530	-0.3098
	Guangdong	-7.0236	-23.5024	2.6307	0.4859	-5.1153	-17.2538	2.5075	-1.1405
	Hainan	0.1039		2.0920	2.4857	-2.7433		1.1546	0.6205
Total	-4.6263	-0.0738	0.3915	1.1422	-4.9117	-1.2289	0.2673	0.5131	
the Middle Reaches of the Yangtze River	Hubei	-1.6903	-0.7016	1.1876	0.7288	-2.6988	-1.2156	0.7844	0.4261
	Hunan	1.4032	-5.6749	3.0606	0.8720	-0.7567	-6.5673	2.2271	-0.1708
	Anhui	0.5760	4.0304	1.3187	1.3313	-0.3768	0.5913	1.5213	1.8110
	Jiangxi	-6.1472	-7.0585	2.2492	0.9607	0.0798	-7.8173	1.7267	0.3290
	Total	-0.9965	2.4102	1.5240	1.0754	-0.8312	-0.3021	1.3642	1.1347
JinJin	Beijing	-70.0731	-6.9023	-0.5257	-1.4876	-47.9554	-4.8596	-1.0128	-1.7568
	Tianjin	-15.8125	-0.7486	0.3498	-2.3530	-11.9053	-0.9406	0.1001	-3.5386
	Total	-24.4703	-3.7523	-0.1479	-2.0487	-17.2819	-2.7475	-0.4793	-3.0726
Northwest	Ningxia	4.4582	-1.1868	2.2558	1.2234	3.5520	-1.7786	2.5055	0.0324
	Xinjiang	5.7361	2.1810	1.3807	4.0494	-1.8313	-0.3836	1.1098	5.5451
	Qinghai		-4.0176				-3.4174		
	Gansu		-2.1544	1.9127	2.8014		-2.2075	2.3168	3.5283
	Shanxi	-2.8669	-0.6733	0.7237	0.7602	-2.8930	-1.6710	0.3076	-0.7108
	Inner Mongolia	15.5037	-2.3560	2.1038	2.3653	1.3610	-2.9601	2.8095	3.6450
Total	3.9945	-0.4607	1.6421	2.1575	-0.6244	-1.7718	1.7321	2.4354	
Southwest	Sichuan	-6.0236	-2.4987	-0.0270	1.8771	-4.5964	-2.3782	-0.4984	2.4568
	Guizhou	-2.8309	-1.9600	0.4578	0.9828	-0.8808	-2.2547	0.6031	2.6904
	Yunnan	4.3386	-0.2050	1.1158	4.8190	0.4751	-1.1099	0.7839	6.2173
	Chongqing								
	Tibet	11.7662	2.3557	1.6657	-1.6061	2.3577	-0.4284		-3.7603
	Guangxi	-1.7029	-12.6565	1.0352	1.4875	-2.1125	-11.1094	0.1160	-0.6745
Total	-0.7884	-1.6456	0.6664	2.6525	-1.3625	-1.8332	0.3987	2.9894	
Northeast	Heilongjiang	32.8521	-8.1919	1.4269	1.0405	16.0660	-7.2827	1.6794	1.4288
	Jilin	13.0522	-12.1029	0.6128	0.1477	5.3394	-11.6393	0.7665	0.1109
	Liaoning	5.2722	-13.1558	0.7712	-0.2558	2.0481	-11.1683	0.9939	-2.5195
	Total	20.4003	-8.5437	0.9394	0.7941	10.3898	-7.5174	1.2006	0.9550