

Geographic concentration and driving forces of agricultural land use in China

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Abstract Since the 1990s, China has entered the middle phase of urbanization which leads to the existence of significant geographic concentration of agricultural land use. The average value of regional concentration degree of ten representative crops in China was 59.03%, showing a high degree of geographic concentration in farming. Some typical agriculture provinces in farming have arisen. The degree of geographic concentration in farming has been enhanced, with the average degree of regional concentration of ten crops increasing considerably by 3.83% in 2009 compared to that in 1990 (55.20%). The spatial growing center of farming was found to move westward and northward during 1990–2009. Meanwhile food production concentrated in the Northeast China and main producing area, and cash crops production concentrated in Northwest China. Off-farm employment of rural labor force, commercialization of agricultural product and regional comparative advantage are the main driving forces of geographic concentration of agricultural land use. Governmental policies with regional differences should be considered to promote further development of agriculture.

Keywords agricultural land use, geographic concentration, driving forces, China

1 Introduction

With the rapid growth and transformation of national economy, great changes and adaptation have happened in regional agricultural land use (Andreae, 1983). The history of agricultural land use in many developed countries suggested that, after industrialization and urbanization, the

development of economy and society will be accompanied by the process of agriculturally regional specialization, while the regional specialization of agriculture will be characterized by the synchronous geographic concentration of industries. For instance, the Corn Belt produced 45% of the total corn yield in America, and rice, potato and cotton all have specific production areas. One third of the total wheat yield in France is produced in Paris Basin, while grapes are primarily grown in southern France (RISTI CAAS, 1979; Zheng and Gu, 2006).

China has entered the transforming phase of the middle term of urbanization since the 1990s (Zhang and Song, 2003). With the rapid process of urbanization, how will the specialization process and the geographic concentration characteristics of agricultural land use in China be? And what are the driving forces? These issues are discussed in the present paper.

As far as the structural arrangement is concerned, the degree of geographic concentration in the industries of ten representative crops like rice, wheat, corn, soybean, potato, cotton, peanut, rape, vegetable and fruits, including the current characteristics and changing trend of agricultural land use, was measured and evaluated by the degrees of regional concentration and productive concentration. We further analyze the primary driving forces for the geographic concentration of agricultural land use and finally propose some relevant policy implications. This paper is attempted to reveal the geographic concentration and the driving mechanism of agricultural land use in China, thereby facilitating reasonable and efficient utilization of regional land resources.

2 Methods and data sources

The degree of regional concentration is used to determine the nationwide degree of geographic concentration in

farming. In particular, this is shown by the cumulative sum of the top five proportions of the sowing area or yield of some crops out of the total sowing area or total yield of the said crop (Krugman and Venables, 1990; Krugman, 1992). The greater the degree of regional concentration of a crop, the higher the nationwide regional specialization. The degree of regional concentration (C_5) can be expressed in Eq. (1):

$$C_5 = \sum_{i=1}^5 S_i \times 100\%, \quad (1)$$

where S_i is the No. i th proportion of the sowing area out of the total sowing area or the i th yield of a crop out of the said crops, which is also called the degree of production concentration of the crop concerned (Lu et al., 2008).

The data of crop sowing area are from China Rural Statistic Yearbook (ASESOSSB, 2011a). Considering the emergence of peasant workers in mid 1990s (Zhu, 1993), we choose 1990–2009 as the study period because of the effect of geographic concentration in farming causing by the off-farm employment of rural labor. The regional difference of natural geographic environment differs greatly, and crop species diversifies in China. The five representative grain crops like rice, wheat, corn, soybean and potato, as well as five representative cash crops like cotton, peanut, rape, vegetable and fruit were selected as present study objects, because they are widely cultivated. Data of sowing area during 1990–2009 were collected and a database in farming was established. It needs to mention that, due to modification of administrative division, Chongqing was integrated with Sichuan Province as a region. Special administrative regions like Hongkong and Macao as well as Taiwan Province were not included in the current study due to data unavailable.

3 Geographic concentration

3.1 Current characteristics

3.1.1 High geographic concentration degree

According to Eq. (1), we calculated the regional concentration degree of ten representative crops in China in 2009. The average value of the degree is 59.03% (Table 1). In other words, above half of the sowing area of farming was centralized in the provinces, cities and districts whose degree of production concentration was ranked at top five. The total sowing area of farming in all the rest 25 provinces is below 50%. It suggests that the degree of industrial concentration of farming is very high and the regional specialization and geographic concentration are rather remarkable. Different crops are different in their degree of industrial concentration. The degree of regional concentration of cotton and soybean is above 70%, and that of potato, wheat, peanut and rapeseed is also above 60%. The degree of regional concentration of corn and rice is about 50%, and that of fruits and vegetables is above 40%.

3.1.2 Development of typical agriculture provinces

Farming in China was mostly centralized in some typical agriculture provinces in 2009, including Hebei and Henan in North China Plain, Heilongjiang and Jilin in Northeast China, Xinjiang Uygur Autonomous Region and Inner Mongolia Autonomous Region in Northwest China and Sichuan, Jiangxi, Hunan, Hubei and Anhui Provinces in Yangtze River Basin. It is noteworthy, in Henan Province, the production concentration degree of six crops is ranked among top five in China (Table 2). These provinces are

Table 1 Degree of regional concentration of ten representative crops in China in 2009

| Crop | Planting area /(10 ³ hm ²) | Degree of production concentration/% | | | | | Degree of regional concentration/% |
|-----------|--|--------------------------------------|----------------|----------------|----------------|----------------|---------------------------------------|
| | | S ₁ | S ₂ | S ₃ | S ₄ | S ₅ | |
| Cotton | 4951.8 | 28.46 | 16.16 | 12.52 | 10.85 | 9.29 | 77.29 |
| Soybean | 9189.8 | 43.61 | 10.56 | 9.14 | 5.08 | 4.76 | 73.15 |
| Potato | 5080.7 | 17.45 | 13.07 | 12.67 | 12.50 | 9.73 | 65.40 |
| Wheat | 24290.9 | 21.67 | 14.59 | 9.86 | 9.70 | 8.55 | 64.37 |
| Peanut | 4376.7 | 22.29 | 17.70 | 8.90 | 7.36 | 6.95 | 63.20 |
| Rapeseed | 7277.8 | 16.02 | 15.25 | 13.96 | 9.92 | 7.40 | 62.55 |
| Corn | 31182.6 | 12.86 | 9.48 | 9.46 | 9.36 | 9.29 | 50.45 |
| Rice | 29626.7 | 13.66 | 11.08 | 9.14 | 8.31 | 7.58 | 49.77 |
| Fruits | 11139.6 | 9.71 | 9.30 | 9.08 | 8.24 | 7.53 | 43.86 |
| Vegetable | 18414.5 | 9.54 | 9.19 | 9.13 | 6.23 | 6.18 | 40.27 |

Table 2 Top five provinces in production concentration degree of ten crops in China in 2009

| Regions | Cotton | Soybean | Potato | Wheat | Peanut | Rapeseed | Corn | Rice | Fruits | Vegetable | Species No. |
|----------------|--------|---------|--------|-------|--------|----------|------|------|--------|-----------|-------------|
| Hennan | 4 | 4 | | 1 | 1 | | 5 | | | 2 | 6 |
| Shandong | 2 | | | 2 | 2 | | 4 | | | 1 | 5 |
| Hebei | 3 | | | 3 | 3 | | 3 | | 2 | | 5 |
| Sichuan | | | 1 | | 5 | 2 | | 3 | | 3 | 5 |
| Anhui | | 2 | | 4 | | 4 | | 5 | | | 4 |
| Heilongjiang | | 1 | | | | | 1 | 4 | | | 3 |
| Guangdong | | | | | 4 | | | | 1 | 5 | 3 |
| Xinjiang | 1 | | | | | | | | 5 | | 2 |
| Hubei | 5 | | | | | 1 | | | | | 2 |
| Hunan | | | | | | 3 | | 1 | | | 2 |
| Inner Mongolia | | 3 | 2 | | | | | | | | 2 |
| Jilin | | 5 | | | | | 2 | | | | 2 |
| Jiangxi | | | | | | 5 | | 2 | | | 2 |
| Jiangsu | | | | 5 | | | | | | 4 | 2 |
| Shanxi | | | | | | | | | 3 | | 1 |
| Gansu | | | 3 | | | | | | | | 1 |
| Guangxi | | | | | | | | | 4 | | 1 |
| Guizhou | | | 4 | | | | | | | | 1 |
| Yunnan | | | 5 | | | | | | | | 1 |

located in socio-economically less developed inland in middle-western region of China. They are not only the production centers of grain crops, but also the centers of geographic concentration of farming. The above provinces play a key role in the development of farming.

3.2 Changing trend

3.2.1 Enhancement of geographic concentration degree

During 1990–2009, the average degree of regional concentration of ten crops increased considerably by 3.83% compared to that in 1990, i.e., 59.03% vs. 55.20%, suggesting that the level of regional specialization and the degree of industrial concentration of farming were further improved. The tendency as a whole was intensified (Table 3).

The changing trend of industrial concentration of different crops differed somewhat. According to the changes of regional concentration of different crops during 1990–2009, the regional concentration degree of soybean, wheat, potato, vegetable, cotton and rapeseed increased. With further intensification of regional labor division and production specialization, production allocation of farming is more centralized at the same time. In particular, the regional concentration degree of soybean increased by 18.21%, which represented the highest growth and the fastest geographic concentration degree. The concentration degree of production in Heilongjiang was increased by

16.11%, so it was the maximal contributor. The degree of regional concentration of wheat was improved by 12.15%. As the largest wheat production, Henan Province is featured by an increased of 6.12% in the degree of production concentration. The degree of regional concentration of potato was also improved by 10.82%, and the planting area in Inner Mongolia, Gansu, Guizhou and Yunnan expanded consistently. The degree of regional concentration of vegetable was increased by 3.87%. The degree of production concentration in Shandong and Jiangsu entered the top five, and ranked at No. 1 and No. 4 in China, respectively. Although the degree of regional concentration of cotton was only increased by 2.64%, the degree of production concentration in Xinjiang was increased by 20.67%. As a consequence, Xinjiang became the biggest cotton-growing region in China, while economically developed Jiangsu Province dropped out of the top five cotton-growing regions. The degree of regional concentration of rapeseeds increased slightly, only by 2.06%. Hubei Province, instead of Sichuan Province, became the biggest rapeseeds producing province. In contrast to the crops mentioned above, the degree of regional concentration of fruits, peanut, corn and rice declined slightly, i.e., by –6.48%, –3.54%, –1.00% and –0.43%, respectively. The degree of industrial concentration decreased slightly; which suggested that regional division of labor and specialized production became weaken and the allocation of farming production was relatively dispersive.

Table 3 Changes in regional concentration degree of ten crops in China 1990–2009

| Crop | Degree of production concentration/% | | | | | | | | | | Degree of regional concentration/% | | |
|---------------|--------------------------------------|---------------|----------------|----------------|----------------|----------------|----------------|---------------|----------------|-----------|------------------------------------|-------|---------|
| | S ₁ | | S ₂ | | S ₃ | | S ₄ | | S ₅ | | 1990 | 2009 | Changes |
| | 1990 | 2009 | 1990 | 2009 | 1990 | 2009 | 1990 | 2009 | 1990 | 2009 | | | |
| Cotton | 25.22 | 28.46 | 16.30 | 16.16 | 14.73 | 12.52 | 10.24 | 10.85 | 8.16 | 9.29 | 74.64 | 77.29 | 2.64 |
| | Shandong | Xinjiang | Hebei | Shandong | Henan | Hebei | Jiangsu | Henan | Hubei | Hubei | | | |
| Soybean | 27.50 | 43.61 | 8.46 | 10.56 | 6.92 | 9.14 | 6.14 | 5.08 | 5.93 | 4.76 | 54.94 | 73.15 | 18.21 |
| | Heilong-jiang | Heilong-jiang | Henan | Anhui | Anhui | Inner Mongolia | Jilin | Henan | Shandong | Jilin | | | |
| Potato | 17.52 | 17.45 | 10.25 | 13.07 | 9.93 | 12.67 | 8.57 | 12.50 | 8.32 | 9.73 | 54.58 | 65.40 | 10.82 |
| | Sichuan | Sichuan | Gansu | Inner Mongolia | Gui zhou | Gansu | Inner Mongolia | Guizhou | Shanxi | Yunnan | | | |
| Wheat | 15.55 | 21.67 | 13.49 | 14.59 | 8.16 | 9.86 | 7.80 | 9.70 | 7.22 | 8.55 | 52.22 | 64.37 | 12.15 |
| | Henan | Henan | Shandong | Shandong | Hebei | Hebei | Jiangsu | Anhui | Sichuan | Jiangsu | | | |
| Peanut | 24.48 | 22.29 | 15.17 | 17.70 | 11.15 | 8.90 | 10.19 | 7.36 | 5.75 | 6.95 | 66.74 | 63.20 | - 3.54 |
| | Shandong | Henan | Henan | Shandong | Guangdong | Hebei | Hebei | Guangdong | Guangxi | Sichuan | | | |
| Rapeseed | 15.25 | 16.02 | 14.06 | 15.25 | 11.36 | 13.96 | 9.99 | 9.92 | 9.83 | 7.40 | 60.50 | 62.55 | 2.06 |
| | Sichuan | Hubei | Anhui | Sichuan | Hunan | Hunan | Hubei | Anhui | Jiangxi | Jiangxi | | | |
| Corn | 11.24 | 12.86 | 10.37 | 9.48 | 10.17 | 9.46 | 10.13 | 9.36 | 9.54 | 9.29 | 51.45 | 50.45 | - 1.00 |
| | Shandong | Heilong-jiang | Jilin | Jilin | Henan | Hebei | Heilong-jiang | Shandong | Hebei | Henan | | | |
| Rice | 13.22 | 13.66 | 9.96 | 11.08 | 9.61 | 9.14 | 9.45 | 8.31 | 7.97 | 7.58 | 50.20 | 49.77 | - 0.43 |
| | Hunan | Hunan | Jiangxi | Jiangxi | Guangdong | Sichuan | Sichuan | Heilong-jiang | Hubei | Anhui | | | |
| Fruits | 12.45 | 9.71 | 12.37 | 9.30 | 12.10 | 9.08 | 7.53 | 8.24 | 5.89 | 7.53 | 50.34 | 43.86 | - 6.48 |
| | Shandong | Guangdong | Shandong | Hebei | Hebei | Shanxi | Liaoning | Guangxi | Shanxi | Xinjiang | | | |
| Vegetable | 10.04 | 9.54 | 8.16 | 9.19 | 6.45 | 9.13 | 5.89 | 6.23 | 5.86 | 6.18 | 36.40 | 40.27 | 3.87 |
| | Sichuan | Shandong | Guangdong | Henan | Henan | Sichuan | Hubei | Jiangsu | Hunan | Guangdong | | | |
| Average value | | | | | | | | | | | 55.20 | 59.03 | 3.83 |

3.2.2 Changes of geographic concentration center

3.2.2.1 Growing center moved westward

During 1990–2009, the proportion of planting area of ten crops in the east region¹⁾ declined slowly in 1990–2000, and decreased rapidly in 2000–2009. The proportion was 37.47% in 1990, but it dropped slowly to 36.25% in 2000. Subsequently, the proportion dropped rapidly to 32.14% in 2009. The proportion of the planting area of the ten crops in the middle region of China was 50.62% in 1990, but it dropped to 50.00% in 2000. However, the proportion

increased to 52.12% in 2009 again. The proportion of the planting area of ten crops in the west region of China was 11.91% in 1990, but increased to 15.74% in 2009 (Fig. 1). Since 2000, the distribution of production in farming in the east region has been shrinking rapidly. It moved toward the middle and west regions of China and centralized therein, namely, the spatial growing center of production moved westward.

3.2.2.2 Growing center moved northward

The proportion of the planting area of the ten crops in the

1) According to geographic location and level of economy development of each province, China was classified into three regions. The east region includes twelve provinces/cities/autonomous regions, i.e. Liaoning, Beijing, Tianjin, Hebei, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Guangxi and Hainan; the middle region includes ten provinces/cities/autonomous regions, i.e. Jilin, Heilongjiang, Shanxi, Henan, Anhui, Hubei, Hunan, Jiangxi, Shaanxi and Sichuan; the west region includes eight provinces/cities/autonomous regions, i.e. Xinjiang, Inner Mongolia, Gansu, Qinghai, Ningxia, Guizhou, Yunnan and Tibet.

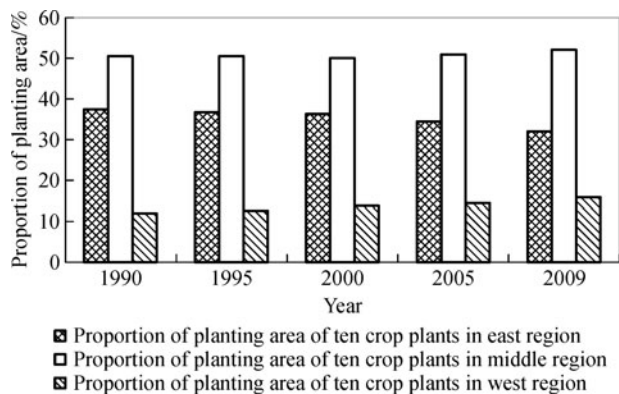


Fig. 1 Proportion of planting area of ten crops in the three regions of China 1990–2009

north region of China increased consistently. Compared to 47.93% in 1990, it increased to 52.02% in 2009. The proportion in the south region however decreased; the proportion was 52.07% in 1990, but it dropped to 47.98% in 2009. The farming in the south region shrank, while that in the north region expanded, suggesting a northward trend of plant spatial growing center²⁾ (Fig. 2).

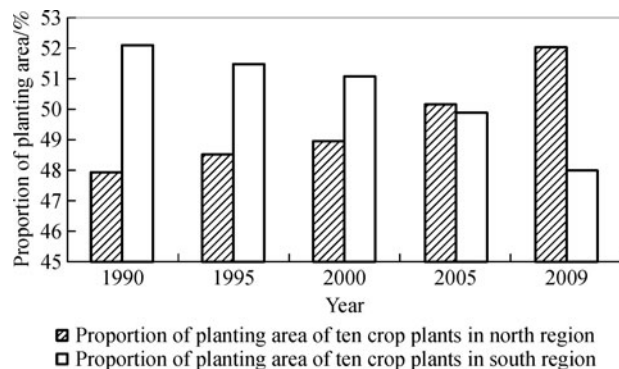


Fig. 2 Proportion of planting area of ten crops in south and north regions of China 1990–2009

3.2.3 Geographic concentration center of different crops

3.2.3.1 Food production concentrated in the Northeast China and main producing area

The center of food production moved clearly northward and concentrated in the north region. The planting area of grain crops in the north region in 2009 accounted for

55.94% of the total planting area in China. It was increased by 7.29% compared to that in 1990, a proportion higher than that of farming mentioned above (Fig. 3).

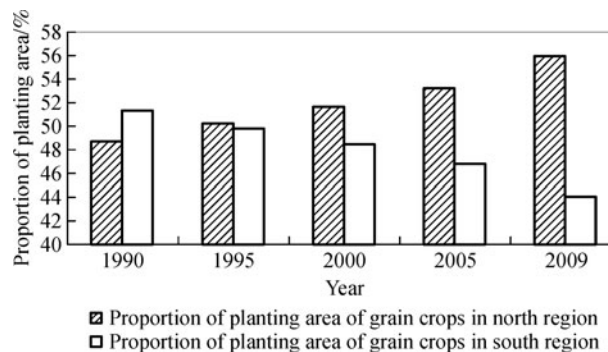


Fig. 3 Proportion of planting area of grain crops in south and north regions in China 1990–2009

The proportion of grain crops in the Northeast China increased drastically, which contributed most to increment of food production in the north region, and accounted for 18.17% of the total planting area in China in 2009, compared to 13.15% in 1990. In particular, the planting area of rice and soybean had a great deal of increment, which accounted for 12.75% and 50.16% in 2009. The food production in the North China increased somewhat, while the planting area of wheat accounted for 51.99% in 2009 (Table 4).

Simultaneously, the proportion of planting area of grain crops in the food main producing area³⁾ increased slowly during 1990–2000, and increased rapidly in 2000–2009. Compared to 70.56% in 1990, it increased slowly to 71.50% in 2000, and then increased to 74.98% rapidly in 2009 (Fig. 4). Since 2000, food production has been concentrating clearly in the main producing area. The regional characteristic of food production was remarkable, which was consistent with the studies of other researchers (Chen, 2011).

3.2.3.2 Cash crops production concentrated in Northwest China

As presented in Table 5, planting area of cash crops increased clearly in Northwest, Southwest, and South China between 1990 and 2009. In Northwest China, compared to 7.69% in 1990, the proportion of planting area of cash crops increased to 12.46% in 2009. The planting

1) According to *Plan for the Capacity of Producing Additional 50 Million-ton Food in China (2009–2020)*, the north region include sixteen provinces/cities/autonomous regions, i.e., Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shandong, Henan, Tibet, Shanxi, Gansu, Ningxia, Qinghai and Xinjiang; the south region includes fifteen provinces/cities/autonomous regions, i.e., Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Hubei, Hunan, Guangdong, Guangxi, Hainan, Sichuan, Chongqing, Guizhou and Yunnan

2) According to *Plan for the Capacity of Producing Additional 50 Million-ton Food in China (2009–2020)*, the main producing area includes the following thirteen provinces/autonomous regions: Heilongjiang, Liaoning, Jilin, Inner Mongolia, Hebei, Jiangsu, Anhui, Jiangxi, Shandong, Henan, Hubei, Hunan and Sichuan

agricultural labor force, farm household tended to grow crop species of high labor productivity, which led to monoculture of planting structure. Macroscale agricultural land use was predisposed to regional specialization. As a result, the degree of geographic concentration in farming was intensified. Meanwhile, off-farm employment of rural labor force increased the market demand for agricultural product, which further promoted the commercialized and specialized production of agricultural product. The latter in turn further improved labor productivity, thereby supplied conditions to the off-farm employment of rural labor force. The comparative advantage resultant from land, labor force, capital and location, also accelerated the process of specialization and geographic concentration in farming (Fig. 5).

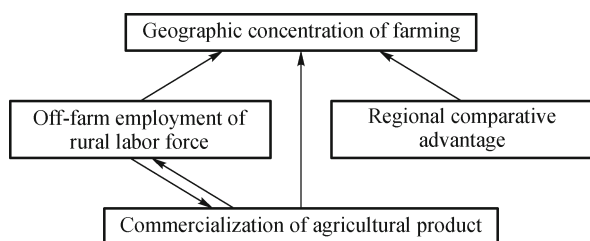


Fig. 5 Theoretical framework of geographic concentration in farming

4.2 Off-farm employment of rural labor force

The off-farm employment rate of rural labor force in China increased consistently, which was increased to 45.48% in 2008. Compared to 20.69% in 1990, with an increase nearly by 1.2 times. The maximal growth rate of off-farm employment of rural labor force was observed at two time points, i.e., around 1993 and after 1999 (Fig. 6), which was consistent with the changing trend of concentration degree of grain crops in the main producing area (Fig. 4). Although the off-farm employment rate of rural labor force increased fast around 1993, the concentration degree of grain production in the main producing area increased slowly due to the redundant labor force in rural areas. Since

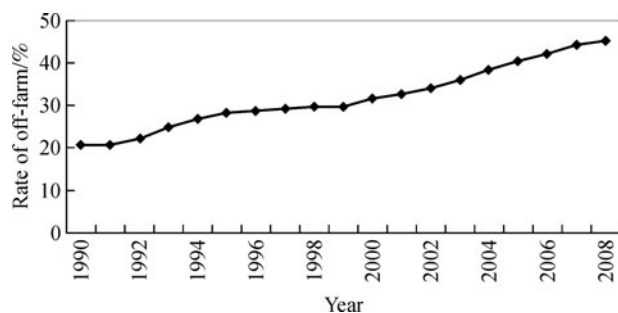


Fig. 6 Rate of off-farm employment of rural labor force in China (1990–2009). Data are from the 60-year statistical data of agriculture of new China (Ministry of Agriculture of China, 2009)

the 1999, with the rapid growth of off-farm employment rate of rural labor force, the concentration degree of grain production in the main producing area also increased rapidly because there is relatively shortage of rural labor force. So the effect of geographic concentration in agricultural land use appeared further.

4.3 Commercialization of agricultural product

Improvement in the commercialization degree of agricultural product accelerated the specialized and geographic concentration process of farming. We calculated the commercialization rate of agricultural product, i.e., the ratio of the quantity of agricultural product sold by each member in a farm household to that produced by each member in a farm household. The harvested produce is proximally to the summation of the produce sold and consumed. Seen from Fig. 7, the marketization level of agricultural product was improved rapidly in China during 1991–2009. Generally, the increasing amplitude of marketization rate of agricultural product was high, compared to 32.30% in 1991, it climbed to 63.53% in 2009, which is almost doubled.

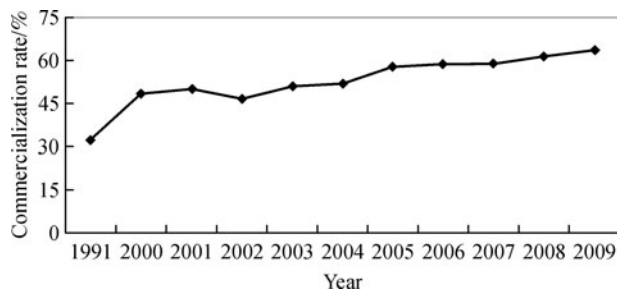


Fig. 7 Commercialization rate of agricultural product in China (1991–2009). Data are from China Yearbook of Rural Household Survey, 2001–2010 (ASESOSSB, 2011b); data in 1992–1999 are missing

4.4 Regional comparative advantage

Since 1990, great changes have taken place in the developmental pattern and level of regional economy in China. The factor endowment and combination of regional land, labor force and capital differed remarkably. The regional comparative advantage promoted the specialization and geographic concentration of farming. To sum up, although the farm land resource in the south-eastern coastal region of China is deficient, the level of economy development is high and this region has advantage of capital, technical and geographic, fruit production in agricultural development and therefore held an important position, and the characteristics of geographic concentration is significant. Farm land resources were relatively sufficient, and the degree of mechanisation which is beneficial for specialized production of grain crops is high

in the North and Central China. So the food production base is mostly centralized in this region. The West China has lots of mountains and the natural conditions like land resource differed profoundly. A good many of regionally characteristic agricultural bases therefore are formed.

5 Conclusions

This paper used planting area of ten representative crops and made an empirical research of geographic concentration of agricultural land use in China. From the current characteristics, there was a high degree of geographic concentration in farming; the average value of regional concentration degree of ten crops was 59.03%. And some typical agriculture provinces have developed, such as Henan, Hebei and Sichuan. According to the changing trend, the degree of geographic concentration in farming has enhanced; the average degree of regional concentration (59.03%) of ten crops in 2009 increased considerably by 3.83% compared to that in 1990 (55.20%). Spatial growing center of farming has moved westward and northward during 1990–2009. In addition, food production concentrated in the Northeast China and main producing area, and cash crops production concentrated in Northwest China. The off-farm employment rate of rural labor force increased consistently. Compared to 20.69% in 1990, it was increased to 45.48% in 2008. The commercialization rate of agricultural product enhanced rapidly; as compared to 32.30% in 1992, it climbed to 63.53% in 2009. These driving forces accelerated the geographic concentration of agricultural land use.

Governmental policies to promote agriculture development should consider the geographic concentration characteristic of agricultural land use. Accordingly, policies like agricultural subsidies should be adjusted to local conditions. Farm households should be guided to grow crops with comparative advantage, thereby accelerating the reasonable utilization of land, labor force and capital. For example, for the sake of food security, subsidies for returning farm land to forest land in the central plain should be reduced advisably, while subsidies for growing grain crops should be increased. For the sake of ecological security, subsidies for returning farm land to forest land in vulnerable ecological area in the west should be promoted, while subsidies for growing grain crops should be reduced.

Acknowledgements This study was supported by the National Natural Science Foundation of China (Grant No. 40971062).

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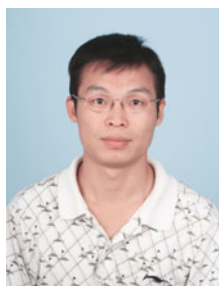
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