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# Pressure on Cultivated Land in Fengxian County, Jiangsu Province, China

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**Abstract** Based on the introduction of the general situation of research region, pressure index model of cultivated land is adopted according to the data of population, cultivated land area, crop sowing area, grain sowing area, and unit grain yield in the *Statistical Yearbook of Fengxian County*. The change of relevant factors of cultivated land pressure index over time is analyzed, as well as the tension level of cultivated land resources. Research shows that the pressure on cultivated land is relatively great in Fengxian County in the years 1999–2005. Grain supply and demand is still under the unsafe state. There will be more prominent contradiction between supply and demand of cultivated land in Fengxian County in the future, and the grain security will under greater pressure. Several countermeasures are put forward to ease the pressure on cultivated land in Fengxian County, in order to realize the sustainable use of cultivated land resources, to ensure the supply and demand balance of grain and cultivated land, and to stabilize and improve the grain productivity in Fengxian County, such as protecting the current cultivated land resources by the strictest protection system of cultivated land, enhancing the intensity of land development and reclamation, enlarging the area of cultivated land, increasing the agricultural sci-tech input, and improving the grain unit yield.

**Key words** Pressure index of cultivated land, Land use, Sustainable development, Fengxian, China

According to the investigation data of land use change, cultivated land area in China has reduced from 130 million hectares in the year 1997 to 122 million hectares in 2005, a net reduction of 8 million hectares within 8 years. Until the year 2008, cultivated land area in China is 122 million hectares<sup>[1]</sup>, only 171.6 hectares more than the red line of cultivated land. Thus, the protection situation of cultivated land becomes tense. In order to ensure the dynamic balance of total cultivated land and the regional food security, Fengxian County, a typical agricultural county in northern Jiangsu, is selected as the research object. Cultivated land pressure of Fengxian County in the years 1999–2005 is analyzed by using the research results of a new round revision of the overall land use planning and the relevant data in the compiling process of planning framework. Based on this, the tension level of cultivated land resources and the safety degree of food are evaluated. And the countermeasures for the sustainable development of cultivated land resources in county region are put forward in order to provide the scientific basis for improving the awareness of cultivated land protection and for strengthening the land protection and management.

## 1 The general situation of research region

Fengxian County is located in the northwest of Jiangsu

Province, the junction of Jiangsu, Shandong, Henan and Anhui Provinces. It belongs to warm temperate zone with semi-humid monsoon climate. Fengxian County has jurisdiction over 14 townships, a total area of 1 449.7 hectares. According to the investigation data of land use change in the year 2005, agricultural land of Fengxian County is 115 549.71 hectares, accounting for 79.71% of the total land area. Construction land is 25 099.77 hectares, accounting for 17.31%. And unused land is 4 320.57 hectares, occupying 2.98%. Resident population in the county is 1 140.3 thousand. And the agricultural population is 807.4 thousand. GDP of Fengxian County is 10 002 million yuan. The primary industry production, secondary industry production, and tertiary industry production are 2 528 million, 4 192 million, and 3 282 million yuan, respectively. According to the socio-economic development trends over the years, Fengxian County is now at the initial stage of accelerated development of urbanization and industrialization. Demand for construction land is under continued growth, and protection of cultivated land becomes more and more serious.

## 2 Data source and research method

**2.1 Data source** Data of research region in each year, such as population, cultivated land area, crop sowing area, grain sowing area, and unit grain yield, are from the *Statistical Yearbook of Fengxian County*. It is assumed that the grain self-sufficient ratio is 100%.

**2.2 Research method** Pressure index of cultivated land reflects the contrast relation between the per capita actual cultivated land and the minimum per capita cultivated land in a region to ensure the food security<sup>[2]</sup>. It can be used to evaluate the tension of cultivated land resources. And its equation is

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$$K = \frac{S_{\min}}{S_a}, \quad (1)$$

$$S_{\min} = \frac{\beta G_r}{Pqk}, \quad (2)$$

where  $K$  is the pressure index of cultivated land,  $S_{\min}$  is the minimum per capita cultivated land ( $\text{hm}^2/\text{people}$ ),  $S_a$  is the per capita actual cultivated land ( $\text{hm}^2/\text{people}$ ),  $\beta$  is grain self-sufficient ratio (%),  $G_r$  is per capita grain demand ( $\text{kg}/\text{people}$ ),  $P$  is unit grain yield ( $\text{kg}/\text{hm}^2$ ),  $q$  is the ratio of grain sowing area to crop sowing area (%), and  $k$  is multiple cropping index. When  $K < 1$ , actual value of per capita cultivated land is greater than the alarm value; and there is no significant pressure on cultivated land. When  $K = 1$ , actual value of per capita cultivated land is equal to the alarm value. And cultivated land needs to be further protected. When  $K > 1$ , there is significant pressure on cultivated land. Grain production can not ensure the normal requirement. And protection measures should be taken.

According to the correlation parameter of cultivated land pressure index, the minimum per capita cultivated land is directly proportional to the per capita grain demand and the grain self-sufficient ratio, and inversely proportional to the unit grain yield, the ratio of grain sowing area, and the multiple cropping index.  $qk$  is actually the use index of sowing cultivated land, and  $Pqk$  actually reflects the productivity of cultivated land. Affected by the temporal and spatial variation of population, the productivity of cultivated land, the per capita consumption level and other factors, the minimum per capita cultivated land varies as well as the per capita actual cultivated land. Thus, pressure index of cultivated land is a dynamic measurement index.

### 3 Result and analysis

#### 3.1 Analysis of the change process of cultivated land

**3.1.1** Analysis of the change of overall cultivated land. Table 1 shows that in the years 1997–2005, the overall cultivated land tends to decrease as the population increases in Fengxian County, a reduction of 555 hectares. But in some years, the overall area of cultivated land increases.

(1) Reduction of cultivated land can be divided into two stages. One is the slow reduction stage of cultivated land in the years 1997–1998, with an overall reduction of 145 hectares of cultivated land. In this stage, Fengxian County shows a rapid economic development. Real estate market and development district construction become active, forming a relatively big demand for land. Cultivated land is occupied by construction projects. And illegal land use is not effectively curbed. The other is the sharp decline stage of cultivated land in the years 2001–2002, with a reduction of 798 hectares. Construction enters into an acceleration phase in this stage and there is a substantial increase in demand for construction land. At the same time, examination and approval of construction land can not effectively control the occupation the cultivated land. And a effective basic farmland protection system has not yet been formed.

(2) Increase of cultivated land can also be divided into two stages. The first stage is the years 1998–2001. In the case of the continuous growth of population and the significant reduc-

tion of cultivated land, Chinese government has promulgated a series of management policies since the year 1997 that strictly protect the cultivated land and restrain the indiscriminate use of cultivated land to some extent, such as the *Circular of the Central Committee of the Communist Party of China and the State Council Concerning Further Enhancing Land Administration and Earnestly Protecting the Cultivated Land, the Freeze the Occupation of Farmland for Non-agricultural Construction Projects, and the Regulations on the Protection of Basic Farmland*. The second stage is the years 2002–2005. Chinese government has promulgated the Notice on Strengthening Reform to Strict Land Management Proulated by State Council and its supporting policies in order to regulate the land management and control. On the one hand, Fengxian County strictly implements the policy of cultivated land protection, strengthens the land enforcement, and regulates the land use. On the other hand, Fengxian County explores the potential of arable land and increases the area of cultivated land by land development, consolidation and reclamation.

**Table 1** Change of cultivated land and population during the years 1997–2005

Year	Total cultivated land// $\text{hm}^2$	Total population $\times 10^4$	Per capita cultivated land// $\text{hm}^2/\text{people}$
1997	76 837	104.28	0.074
1998	76 692	105.57	0.073
1999	76 731	106.04	0.072
2000	76 795	109.38	0.070
2001	76 828	109.74	0.070
2002	76 030	109.80	0.069
2003	76 097	109.51	0.069
2004	76 308	110.24	0.069
2005	76 282	110.34	0.069

Note: Data are from the 1997–2005 *Fengxian Statistical Yearbook*.

**3.1.2** Analysis of per capita cultivated land change. Table 1 shows that the per capita cultivated land of Fengxian County has mainly experienced three stages in the years 1997–2005, which are sharp decline, slow rise and slow decline. Per capita cultivated land has decreased from 0.074 hectare to 0.069 hectare, which is only a little higher than the alertness thread of the per capita cultivated land (0.053 hectare) formulated by Food and Agriculture Organization (FAO) [3].

Per capita cultivated land declines rapidly in the years 1997–2000, which has certain relations with the population increase and cultivated land decrease. In the years 2001–2005, per capita cultivated land changes a little. In the year 2003, per capita cultivated land shows a slight increase, compared with the last year. It is closely associated with the implementation of strict protection policy of cultivated land in China, and the development and consolidation of cultivated land in Fengxian County.

**3.2 Analysis of the changes of grain sowing area and grain unit yield** Table 2 shows that the grain sowing area decreases year by year in the years 1999–2003, an annual decrease of 9 412.50 hectares. Grain sowing area increases rapidly in the years 2004 and 2005, with an increase of 21 420 hectares in the year 2004 and 3 150 hectares in the year 2005.

The ratio of grain sowing area to crop sowing area declines

from 0.73 in the year 1999 to 0.43 in the year 2003. In the years 2004–2005, the ratio increases, but it is still lower than the ratio in 1999. In the year 2005, grain yield in Fengxian County shows a sharp decrease due to the natural disasters.

In the year 2004, the main driving force for the increase of grain sowing area is the support policies for grain production, which are the reduction of agricultural tax and the tax on special agricultural products, the protection of cultivated land and grain price, the direct grain subsidy, the seed subsidy and the subsidy to agricultural machinery and tools. As one of the three granaries in China, Jiangsu Province has implemented related supporting policies to stimulate the enthusiasm of farmers to plant grain<sup>[4]</sup>.

**Table 2** The unit grain yield and the ratio of grain sowing area to crop sowing area in the years 1999–2005

Year	Grain sowing area// hm <sup>2</sup>	Crop sowing area//hm <sup>2</sup>	Ratio of grain sowing area to crop sowing area	Unit grain yield kg/hm <sup>2</sup>
1999	93 440	127 360	0.73	5 878.64
2000	73 410	127 180	0.58	5 495.16
2001	67 510	132 500	0.51	5 665.83
2002	66 310	131 040	0.51	5 739.71
2003	55 790	129 720	0.43	4 271.38
2004	77 210	129 810	0.59	5 591.25
2005	80 360	128 700	0.62	4 738.68

Note: Data are from the 1999–2003 *Fengxian Statistical Yearbook*.

### 3.3 Calculation and analysis of cultivated land pressure index

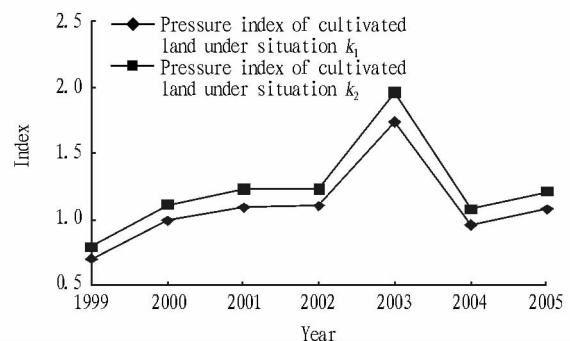
Assuming that the grain self-sufficient ratio is 100%, grain pressure index in the years 1999–2005 is analyzed, that is the proportion of minimum per capita cultivated and in the actual per capita cultivated land of Fengxian County under grain supply security. In the years 1999–2005, Fengxian County is at the initial stage of industrialization. A grain security demand of 400 kilograms in a well-off society is taken as the per capita grain demand of Fengxian County during this period<sup>[5]</sup>. According to the data collected, multiple cropping index of Fengxian County still maintains at the 1.6–1.8 in the years 2002–2005. According to the equations (1) and (2) and the data in Table 2, pressure index change of cultivated land is calculated when the multiple cropping index is  $K_1 = 1.6$  and  $K_2 = 1.8$ . The following conclusions can be obtained from Fig. 1:

(1) Calculation result of cultivated land pressure index shows that in the years 2000–2005, the pressure index of Fengxian County is significant with  $K$  value more than 1, showing that grain supply is more than demand and grain is under the unsafe state, that is, the per capita grain yield is less than 400 kilograms. Grain sowing area is decreasing gradually in the years 2000–2003, with the increase of cultivated land pressure. In the year 2004, cultivated land pressure and the pressure on food self-sufficiency have eased, but have still threatened the grain security of Fengxian County, due to the policy of direct agricultural subsidy, the increase of grain sowing area and grain yield in Feng County, and the low multiple cropping index (1.6). In the year 2005, although grain sowing area increases, grain yield declines due to the damage of natural disasters. When multiple cropping index is 1.8, pressure index of

cultivated land falls to less than the warning value in the year 2004.

(2) From the aspect of the influencing factors of cultivated land pressure index, one of the approaches to ease the pressure on cultivated land is to improve the grain yield. Grain yield can be improved through enhancing multiple cropping index, grain sowing area and unit grain yield. Per capita grain demand increases as the enhancement of living standard.

(3) With the rapid development of society and economy, there is an increasing demand for land during construction in Fengxian County, along with the increase in both population and per capita food consumption. In the future, there will be even more acute contradiction between supply and demand of cultivated land in Fengxian County. And the difficulty in supply and demand balance of grain will further increase in Fengxian County. Without taking effective measures or protecting cultivated land resources strictly, grain supply and demand will be unsafe in the future in Fengxian County.



**Fig. 1** Change of pressure index of cultivated land in Fengxian County in the years 1999–2005

## 4 Countermeasures for cultivated land protection

Faced with the increasingly severe pressure on cultivated land protection and the huge pressure on cultivated land, we put forward several countermeasures to ease the pressure on cultivated land in Fengxian County, to strengthen the cultivated land protection, to ensure the supply and demand balance of grain and cultivated land, and to stabilize and improve the grain productivity in Fengxian County.

### 4.1 Protecting the current cultivated land resources by the strictest protection system of cultivated land

Firstly, further improve the policy system of cultivated land protection and establish the system of objective responsibility for cultivated land protection. Based on the reasonable determination of cultivated land protection objectives in different administrative regions, governments at township level should strengthen their responsibility for cultivated land protection, set up performance appraisal system for cultivated land protection, and improve public participation and supervision system for cultivated land protection, establish disclosure system for additional information and cultivated land occupation, reduce the protection and supervision costs of cultivated land by information publicity, and offer convenience for public participation in land protection and

supervision. Secondly, strictly implement the land use control system; and restrict the transformation from cultivated land to construction land. Thirdly, carry out the system of compensations to cultivated land to be occupied; and increase the area and quality of cultivated land. Fourthly, strengthen the enforcement of the law of land. Government should combat the behaviors of destruction and occupation of basic farmland, and investigate the illegal occupation of farmland and the behavior against the requisition-compensation balance policy according to the law.

**4.2 Enhancing the intensity of land development and reclamation; enlarging the area of cultivated land** According to the *Land Development and Planning of Fengxian County*, land reclamation and consolidation are carried out in Fengxian County in the years 2001 – 2005, increasing 913.24 hectares cultivated land. And it is planned in the years 2005 – 2010 that there will be 12 461.07 hectares cultivated land more. And there are great potentials in the development and reclamation of land and cultivated land, and the consolidation of rural residents. At the same time, government should carry out the reserve resource management of newly-added cultivated land and the cultivated land with development potential, establish reserve institution for cultivated land, and ensure the supply and demand balance of cultivated land.

**4.3 Increasing the agricultural sci-tech input; improving the grain unit yield** Firstly, agricultural sci-tech input should be increased in order to accelerate the transformation and promotion of agricultural science and technology, to cultivate new varieties of plants and animals with high yield, high quality and multiple resistance, and to enlarge the coverage of high yield and high quality varieties. Secondly, the traditional planting behavior and mode should be changed in order to develop intercropping, to enhance multiple cropping index, and to further in-

crease unit grain yield. Thirdly, scientific research and technological innovation of cultivated land protection should be strengthened in order to develop conservation tillage, soil fertility enhancement, medium-and low-yield cropland improvement and degraded land rehabilitation. Fourthly, government should vigorously promote the adjustment of grain industrial structure and product structure, adjust the grain production into the optimum state, take the road of high yield, high quality, low consumption, and high efficiency, enhance the comprehensive capability of grain production, and realize the sustainable development of grain economy.

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