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A Study on Agricultural Land Consolidation Potential in Changfeng County

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Abstract In this paper, we study the agricultural land consolidation quantity potential (including theoretical quantity potential and actual quantity potential) and quality potential in Changfeng County, use the new arable land area to denote the quantity potential, and use the food production improved after agricultural land consolidation to represent quality potential. On this basis, we measure and evaluate the agricultural land consolidation potential in Changfeng County.

Key words Agricultural land, Consolidation potential, Changfeng County

1 Introduction

Changfeng County (116°52′–117°00′ E, 31°55′–32°33′ N), as "North Gate" of the provincial capital Hefei of Anhui Province, has superior location and convenient transportation. It traverses Jianghuai Watershed, bordering Dingyuan and Feidong to the east, Shouxian to the west, Hefei urban area to the south, Huainan to the north. The maximum distance from the east to the west is 42 km, and the maximum north-south span is 67 km^[1]. The county has a total area of 1842 km², and a total population of about 800000. It administers 14 townships (towns), 1 provincial economic development zone and a state-owned farm. In 2015, the county's economy kept rapid growth trend, achieving annual GDP of 36.1 billion yuan, an increase of 13%, and the main economic indicators were firmly in the "first phalanx" of scientific development in Anhui Province. Changfeng is located in the subtropical humid climate and warm temperate semi-humid climate transition zone, with rich light, heat and water resources suitable for the growth of a variety of crops. The soil shows transitional features and has moderate pH of 6–7. The average annual temperature is 15.4 °C, the ground temperature is 17.6 °C, and the total amount of radiation is 111.9 kcal/cm². It has 2113.3 hours of sunshine, 224 days of frost-free period, potential evaporation of 1573.8 mm, and average annual precipitation of 925.6 mm^[2]. According to the land use change survey data and land use base conversion results in Anhui Province in 2015, Changfeng had a total land area of 184138.78 ha in the first half of 2015, including 148203.11 ha of agricultural land (80.48%), 28979.97 ha of construction land (15.74%), and 6955.65 ha of other land types (3.78%). The arable land area was 11069.73 ha, accounting for 74.69% of agricultural land area; garden plot area was 103.05 ha, accounting for 0.07% of agricultural land area; woodland area was 7709.67 ha, accounting for 5.21% of agricultural land area; grassland

area was 21.51 ha, accounting for 0.01% of agricultural land area; other agricultural land area was 29672.15 ha, accounting for 20.02%.

2 Agricultural land consolidation potential in Changfeng County

2.1 Calculation of agricultural land consolidation potential

2.1.1 Quantity potential. Quantity potential is calculated as follows: *Quantity potential = Area of the agricultural land to be consolidated × New arable land coefficient.* (i) Calculation of new arable land coefficient. Using systematic analysis and major investigation, it is calculated mainly based on the land use change survey data and basic farmland data in land use plan. First of all, the new arable land information in the typical agricultural land consolidation project implemented in Changfeng County is collected, and then the new arable land coefficient is adjusted, and finally the new arable land coefficient is determined. (ii) Measurement of scale of the agricultural land to be consolidated. One is to deduct the area of sloping land of more than 25°, and the other is to deduct the non-basic farmland area combined with the area of sloping land of more than 15°. The former represents the theoretical potential and the latter represents the actual potential. (iii) Operation steps. Based on the statistical analysis of land use change survey data and basic farmland data in land use plan, coupled with the field survey results, the scale of agricultural land to be consolidated is determined. The new arable land coefficient in the agricultural land consolidation project is calculated as follows:

$$B_i = \Delta S / S_i \quad (1)$$

$$\alpha = \sum_i^n = 1B_i / n \quad (2)$$

where $i = 1, \dots, n$, n is the number of the project that has been completed in one township (town); ΔS is the new arable land area in the project area; S_i is the consolidation scale in the project area; B_i is the new arable land coefficient in the project area; α is the new arable land coefficient in townships (towns)^[5].

2.1.2 Quality potential. Calculation methods include yield im-

provement method, grade improvement method and productivity improvement method, and this paper chooses yield improvement method. It is calculated as follows; $Grain\ yield\ increase = (New\ arable\ land\ area\ after\ agricultural\ land\ consolidation \times Average\ arable\ land\ yield\ in\ the\ administrative\ area) + (Agricultural\ land\ consolidation\ scale \times Average\ increase\ in\ arable\ land\ yield\ by\ arable\ land\ consolidation\ in\ the\ administrative\ area)$. According to agricultural statistics and actual investigation data, the designated grain crop yield in different areas is regarded as the actual total yield of the designated grain crop in different areas. Then, according to the standard grain conversion factors and actual cropping systems, the grain yield of agricultural land in different townships (towns) is measured, and based on the previous arable land

yield, the yield increase after consolidation is measured.

2.2 Calculation results of agricultural land consolidation potential in Changfeng County

2.2.1 Theoretical agricultural land consolidation quantity potential.

Based on the above-described calculation methods and formula, the agricultural land with slope of less than 25° in Changfeng County is regarded as the measuring object. The new arable land coefficient about the towns or townships of Changfeng is firstly calculated according to the above equation, and then the area of sloping land of more than 25° is deducted from the area of the agricultural land to be consolidated (area of sloping land of more than 25° is 0) to finally get the theoretical quantity potential (Table 1).

Table 1 Calculation results of theoretical agricultural land consolidation quantity potential in Changfeng County

Unit: ha, %

Townships (towns)	Area of the agricultural land to be consolidated	New arable land coefficient	Theoretical quantity potential
Total	31796.92	3.50	1112.89
Shuihu Town	1700.29	3.87	65.80
Xiatang Town	6027.62	2.62	157.92
Yangmiao Town	1224.52	4.04	49.47
Zhuxiang Town	1349.29	5.09	68.68
Wushan Town	1942.00	3.60	69.91
Zhuangmu Town	202.34	4.54	9.19
Zuodian Township	670.38	4.96	33.25
Yijing Township	1101.54	4.39	48.36
Taolou Township	1185.68	3.09	36.64
Luotang Township	2145.92	4.45	95.49
Duji Township	4511.60	3.10	139.86
Zaojia Township	1490.59	5.55	82.73
Shuangdun Town	5493.30	2.75	151.07
Gangji Town	2707.27	3.83	103.69
Shuangfeng Economic Development Zone	0.00	0.00	0.00
Shuihu Farm	44.59	1.31	0.58

Table 2 Calculation results of actual agricultural land consolidation quantity potential in Changfeng County

Unit: ha, %

Townships (towns)	Area of the agricultural land to be consolidated	New arable land coefficient	Actual quantity potential
Total	26526.01	3.50	928.41
Shuihu Town	813.46	3.87	31.48
Xiatang Town	5291.33	2.62	138.63
Yangmiao Town	905.36	4.04	36.58
Zhuxiang Town	1095.08	5.09	55.74
Wushan Town	1552.48	3.60	55.89
Zhuangmu Town	112.81	4.54	5.12
Zuodian Township	517.90	4.96	25.69
Yijing Township	1089.40	4.39	47.82
Taolou Township	1145.94	3.09	35.41
Luotang Township	2003.45	4.45	89.15
Duji Township	4277.58	3.10	132.60
Zaojia Township	1262.49	5.55	70.07
Shuangdun Town	4980.23	2.75	136.96
Gangji Town	1921.36	3.83	73.59
Shuangfeng Economic Development Zone	0.00	0.00	0.00
Shuihu Farm	40.15	1.31	0.53

2.2.2 Actual agricultural land consolidation quantity potential.

When the basic farmland is demarcated based on general land use

plan (2006 – 2020), the arable land and possibly occupied by the future construction land and the arable land in the construction zone with certain conditions is not included in basic farmland protection areas, and the arable land in basic farmland protection areas is relatively stable in the planning stage. In accordance with the technical requirements of arable land consolidation, the arable land with slope of less than 15° in the basic farmland is consolidated, and the potential generated is just the agricultural land consolidation potential most likely to be realized. Through survey and statistical analysis of basic farmland in Changfeng County, we can get the area of contiguous arable land with slope of less than 15° in the basic farmland, and after deducting the area of agricultural land that has been consolidated, we can calculate the area of the agricultural land to be consolidated. According to the agricultural land consolidation quantity potential formula, by deducting the non-basic farmland area and the area of sloping land of more than 15° from the area of the agricultural land to be consolidated, we can get the actual quantity potential. The results are shown in Table 2.

2.2.3 Agricultural land consolidation quality potential. The improvement of agricultural land quality is mainly reflected in the following aspects: (i) infrastructure is improved to enhance the production capacity; (ii) a series of engineering and biological measures are implemented to change the topsoil structure so as to release soil organic matter, and increase soil fertility and food production; (iii) through land leveling, irrigation level of farmland will be greatly enhanced, which can reduce labor intensity and labor costs of farmers, thereby improving land utilization rate and productivity^[7]. The agricultural land consolidation quality potential is reflected in arable land productivity and comprehensive arable land production capacity. According to the above quality potential formula, we can calculate the quality improvement potential of the agricultural land with slope of less than 15° in the county. Based on the above formula, we calculate the new total grain output to be 45600 t after arable land consolidation, the potential for increase per ha is about 1500 kg, and arable land quality increases by 23.92% after consolidation. The agricultural land quality improvement in various townships or towns can be shown in Table 3.

Table 3 Calculation results of agricultural land consolidation quality potential in Changfeng County

Unit: ha, t

Townships (towns)	Area of the agricultural land to be consolidated	New arable land quantity	Quality potential
Total	26526.01	928.41	45610.15
Shuihu Town	813.46	31.48	1417.58
Xiatang Town	5291.33	138.63	8806.22
Yangmiao Town	905.36	36.58	1587.37
Zhuxiang Town	1095.08	55.74	1992.11
Wushan Town	1552.48	55.89	2679.15
Zhuangmu Town	112.81	5.12	201.33
Zuodian Township	517.90	25.69	937.91
Yijing Township	1089.40	47.82	1933.96
Taolou Township	1145.94	35.41	1940.93
Luotang Township	2003.45	89.15	3564.17
Duji Township	4277.58	132.60	7247.80
Zaojia Township	1262.49	70.07	2333.06
Shuangdun Town	4980.23	136.96	8329.06
Gangji Town	1921.36	73.59	3343.44
Shuangfeng Economic Development Zone	0.00	0.00	0.00
Shuihu Farm	40.15	0.53	63.52

3 Agricultural land consolidation potential level and distribution in Changfeng County

With the townships or towns in Changfeng County as unit, based on the calculation results of actual agricultural land consolidation quantity potential, we use cluster analysis to determine the level and distribution of agricultural land consolidation potential in Changfeng County. Based on the actual quantity potential, we grade the agricultural land consolidation potential in Changfeng County according to the size. Due to difference in actual agricultural land consolidation quantity potential between calculation units, we can divide the agricultural land consolidation potential into four levels according to the potential value. Potential value > 105 (Level I potential areas); potential value = $70 - 105$ (Level II potential areas); potential value = $35 - 70$ (Level III potential areas); potential value < 35 (Level IV potential areas). It is regar-

ded as the evaluation standard of agricultural land consolidation potential, and the agricultural land consolidation potential areas are divided, which can ensure reasonable arrangement of land consolidation projects and perfect quality and quantity management of land resources. Level I potential townships or towns (Duji, Xiatang and Shuangdun); Level II potential townships or towns (Luotang, Zaojia and Gangji); Level III potential townships or towns (Yangmiao, Taolou, Yijing, Wushan and Zhuxiang); Level IV potential townships or towns (Zhuangmu, Shuihu, Zuodian, Shuangfeng and Shuihu).

4 Conclusions

The agricultural land distribution is relatively concentrated in Changfeng County, and there is a lot of land with high level of

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the first principal component can represent the change in the 10 indicators to meet the requirements of this analysis. We only need to get the factor loading matrix of the first principal component. As can be seen from Table 4, the load of the first principal component

on 10 indicators is similar, but the load is high on C_1 , C_3 , C_7 and C_{10} . It can be found that the main driving forces affecting the arable land change in Jieshou City are social and economic driving forces.

Table 3 Eigenvalues and variance contribution rate of the principal component

Principal component	Eigenvalues	Variance contribution rate//%	Cumulative variance contribution rate//%
1	9.282	92.818	92.818
2	0.567	5.674	98.492
3	0.101	1.012	99.504
4	0.022	0.223	99.727
5	0.017	0.165	99.893
6	0.008	0.076	99.969
7	0.003	0.028	99.997
8	0.000	0.003	100.000
9	1.92E -07	1.92E -06	100.000
10	-3.07E -18	-3.07E -17	100.000

Table 4 Load value matrix of principal component

Original variable	First principal component	Original variable	First principal component
C_1	0.994	C_6	0.953
C_2	0.986	C_7	0.993
C_3	0.991	C_8	0.983
C_4	0.984	C_9	0.810
C_5	0.933	C_{10}	0.992

4 Conclusions

(i) The principal component analysis results show that one of the main factors that constitute the principal component is rural per capita income (C_{10}). Low income level reduces the enthusiasm of farmers for growing grain, and the means of production can not be improved, resulting in decreased quality of arable land. (ii) The change in the level of economic development has a very significant impact on arable land quantity change. Due to low income and long income cycle in agriculture, more people are willing to invest in the tertiary industry-related industries, thus getting more social investments. The development of the tertiary industry has attracted

a large number of rural laborers to work in city, reducing the agricultural labor and compressing the space for cultivated land use. (iii) The process of urbanization increases the demand for urban construction land, including urban infrastructure construction land demand, industrial land demand and housing land demand. Although the urban environment has been improved, the arable land resources are reduced, that is, unreasonable and excessive land occupation in the industrialization and urbanization process causes considerable land resources to be used for non-agricultural construction.

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consolidation potential, about two-thirds of the total land. The future agricultural land consolidation projects are mainly distributed in Level I potential areas: Xiatang Town, Shuangdun Town, Duji Township and the surrounding areas. By carrying out agricultural land consolidation and taking the measures of high-standard farmland construction, farm road adjustment, shelterbelt construction and ditch transformation, the theoretical quantity potential that can be achieved is 1112.89 ha, while the actual quantity potential that can be achieved is 928.41 ha, and the food production is expected to increase by 45600 t.

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