Asian Agricultural Research 2016, 8(7): 44 –47, 52

Research of Farmland Quality Evaluation Based on Land Consolidation——A Case Study of Land Consolidation Project in Mofang Village, Daixian County, Shanxi Province

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Abstract Taking land consolidation project in Mofang Village of Daixian County as an example, on the basis of counting natural and utilization grades before and after farmland consolidation, farmland quality in the project region after the consolidation is evaluated.

Key words Daixian County, Land consolidation, Farmland quality, Evaluation

1 Introduction

In 2010, the State Council issued the *Notice on Strictly Standardizing the Pilot for the Balance between Increase and Decrease of Urban and Rural Construction Land and Conscientiously Doing a Good Job in Rural Land Consolidation Work* (Guofa [2010] 47), which further clearly put forward that "quality assessment and acceptance of the newly increased farmland by land consolidation should be conducted by technical specifications and standards of farmland grading". The requirement clearly points out that farmland quality grade evaluation must be conducted after land development and consolidation project finish, and technical method of quality assessment of the newly added farmland is unified, making that quality acceptance of the newly added farmland by land development and consolidation has quantization standard, and conversion work of the supplemented farmland quantity and quality by the grade obtains substantive promotion. The evaluation of farmland quality grade is conducted after land development and consolidation project finish, and quality of agricultural land in the project region is identified again. By contrasting and analyzing changes of agricultural land in quantity and quality before and after the project implementation, the contribution of land development and consolidation project to improving grain production capacity of agricultural land is quantized. The target is to analyze grain production capacity by evaluating the grade of agricultural land in the project region after land development and consolidation project finish, which could provide technical support for conversion of farmland requisition-compensation balance according to the grade and quality report of the developed farmland.

2 General introduction of the project region

The project region involves Shangmenwang Village, Xiamenwang Village, Nanjiazhai Village, Mofangbao Village and Shilipu Village of Mofang Township, Daixian County, and its geographical position is at 112°59′33″-113°03′30″ E, 39°04′50″-39°06′53″ N. The east of project region is to Ershilipu Village; south extends to the boundary of township; north near National Highway 108; south borders coastal area of the Hutuo River. Total scale of the developed and arranged land is 651.91 hm^2.

3 Grade evaluation of farmland quality after land consolidation

3.1 Working base map The current arable land of the *Consolidation Project of Basic Farmland in the Hutuo River Basin of Mofang Village of Daixian County* takes status quo map of land use as base map, and the newly added farmland takes completion map as base map. They are overlapped with grading result map of agricultural land (natural quality grade map, use grade map and economic grade map) in the project region, which is taken as working base map of farmland quality grade evaluation.

3.2 The related parameters of farmland quality grade evaluation

3.2.1 Standard cropping system, reference crop and the designated crop. Standard cropping system: standard cropping system of the farmland quality evaluation mainly indicates plantation system, and it is single cropping system in Daixian County.

Reference crop: spring maize is determined as reference crop of agricultural land grading in Shanxi Province.

The designated crop: according to the designated crop for the last round of agricultural land grading, the designated crops for agricultural land grading in Daixian County are spring maize, millet, potato and soybean. The project region all belongs to central plain zone of District 3, including Mofangbao Village, Nanjiazhai Village, Shilipu Village, Shangmenwang Village and Xiamenwang Village, and the designated crop is spring maize.

3.2.2 Division of grading factor index zone Grading factor index zone is the zone of grading factor evaluation index system calculating natural quality score of agricultural land. According to

Received: June 10, 2016 Accepted: July 25, 2016
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terrain characteristics, combining soil and its environmental factors, and taking the principle of dominant factor, the principle of regional differentiation, the principle of boundary integrity and the principle of coordination with surrounding county (city and district) as the guidance, Daixian County is divided into three grading factor index zones: Wutaishan district of Hengshan (District 1), basin district of Xinding (District 2) and basin district of Xinding (District 3). The project belongs to Grade-one index district (loess plateau district), and Grade-two index district is basin district of Xinding (District 3), and the five villages all belong to the central plain zone.

3.3 Calculation of natural quality score and division of natural quality grade

3.3.1 Classification of each grading factor and scoring rule table. According to factor index zone, corresponding index grade of grading factor, quality score and the designated crop are used to make relationship table of "designated crop – grading factor – natural quality score". According to the planting situation of the project, the designated crop in District 3 of Xinding basin is "spring maize", and scoring rule is shown as Table 1.

Table 1 Scoring rule of "designated crop – grading factor – natural quality score" in the project region

Grade-two index district	Factor index district	Score of the designated crop (spring maize)	Grading factors		
			Organic matter	Surface texture	Guaranteed probability of irrigation
Xinding basin district (District 3)	District 3	100		Loam	Sufficiently meeting
		90		Clay	Basically meeting
		80	Grade 3		
		70	Grade 4	Sandy soil	Generally meeting
		50			Without irrigation condition
Weight		0.45	0.25	0.3	

3.3.2 Calculation of natural quality score. According to the weight of "designated crop – grading factor – natural quality score" and scoring rule in Daixian County, natural quality score of each grading factor for the designated crop is calculated by factor method. Via weighted mean, natural quality score of agricultural land in each evaluated unit of farmland quality grade in the project region is calculated according to the designated crop. Calculation formula for natural quality score of agricultural land is as below[1]:

$$C_{Lij} = \frac{\sum_{k=1}^{m} w_k \cdot f_{ijk}}{100}$$

where W_k is the weight of the k^{th} grading factor; C_{Lij} is natural quality score of agricultural land for the designated crop in the grading unit; i is the serial number of grading unit; j is the serial number of designated crop; k is the serial number of grading factor; m is the number of grading factor; f_{ijk} is index score of the kth grading factor for the j^{th} kind of designated crop in the ith grading unit, and its value is (0-100].

Via the calculation, scoring situation of grading factor for each designated crop in the evaluated unit of farmland quality grade after project implementation and calculation result of natural quality score are shown as Fig. 1.

3.4 Calculation of land utilization coefficient and division of utilization grade To sufficiently reflect management status of agricultural land, it needs land economic coefficient modifying utilization grade index of agricultural land, thereby obtaing agricultural land grade index. Land economic coefficient embodies relative difference for ratio of yield and cost, and reflects spatial difference distribution rule of land input-output in different regions and different profits generated by different land inputs from the farmers.

3.4.1 "Yield – cost" index[2] of the designated crop at the sampling site. Calculation formula for "yield – cost" index of the designated crop is as below:

$$a_j = \frac{Y_j}{C_j}$$

where a_j is "yield – cost" index of the sampling site; Y_j is actual per unit area yield of the j^{th} kind of designated crop; C_j is actual cost of the j^{th} kind of designated crop at the sampling site.

According to the obtained per unit area input and output data of the designated crop by investigation at the sampling site of the project region, using the above formula, "yield – cost" index of the designated crop at each sampling site of the project region is calculated, and results are shown as Table 2.

3.4.2 The maximum "yield – cost" index of the designated crop. The designated crop in the project region is spring maize, and its "yield – cost" index is 5.0 kg/yuan.

3.4.3 Land economic coefficient[3] of the designated crop at sampling site. Land economic coefficient of the designated crop at sampling site is calculated according to below formula:

$$K_{cij} = \frac{a_{ij}}{A_j}$$

where K_{cij} is land economic coefficient of the j^{th} kind of designated crop at the ith sampling site; a_{ij} is "yield – cost" index of the j^{th} kind of designated crop at the ith sampling site; A_j is the maximum of "yield – cost" index for the jth kind of designated crop in Daixian County. According to the formula, land utilization coefficient of the designated crop at each sampling site is calculated, and results are shown as Table 2.

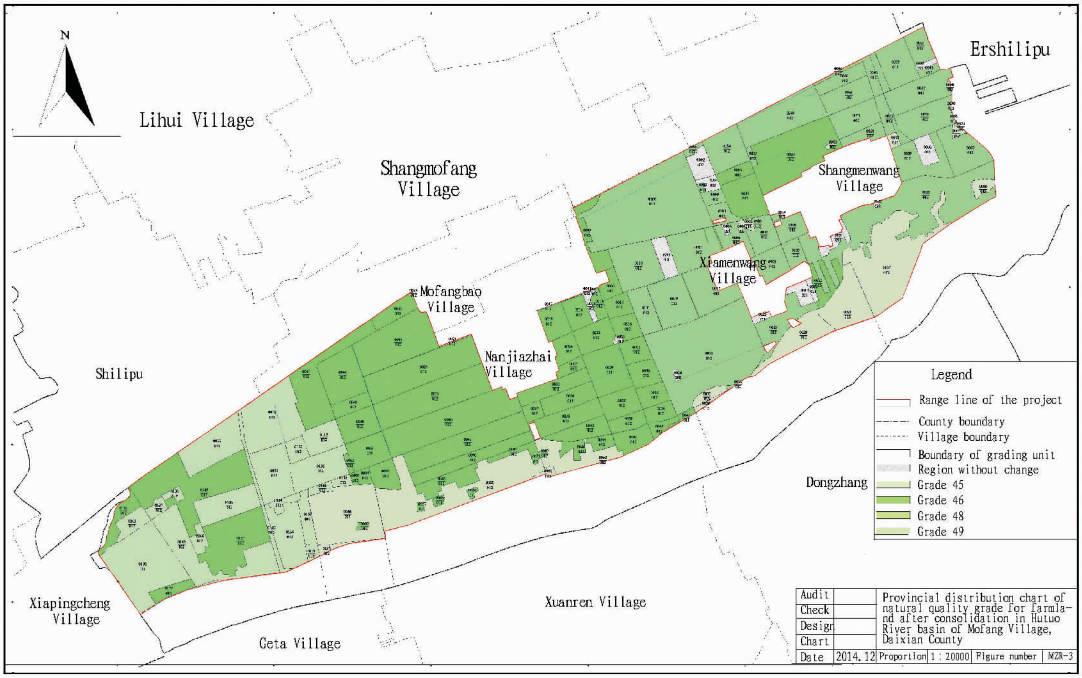

Fig. 1 The distribution of natural quality grade in the project region after land consolidation

Table 2 Calculation result of land economic coefficient in each administrative village

Administrative villages	Actual yield kg/hm^2	The designated crop	Area hm^2	Weight of area proportion	Actual cost of the designated crop $yuan/hm^2$	Yield-cost index at sampling site	The maximum yield-cost index	Land economic coefficient at sampling site	Land economic coefficient in administrative region
Mofangbao Village	10 000	Spring maize	53.66	0.94	5 000	2.00	5	0.400	0.393
	7 200	Spring maize	2.24	0.06	5 000	1.44	5	0.288	
Nanjiazhai Village	9 800	Spring maize	156.34	0.946	5 000	1.96	5	0.392	0.387
	7 350	Spring maize	2.22	0.054	5 000	1.47	5	0.294	
Shilipu Village	9 050	Spring maize	97.08	0.961	5 000	1.81	5	0.362	0.359
	7 100	Spring maize	0.88	0.039	5 000	1.42	5	0.284	
Shangmenwang Village	9 300	Spring maize	168.57	0.970	5 000	1.86	5	0.372	0.369
	6 950	Spring maize	3.44	0.030	5 000	1.39	5	0.278	
Xiamenwang Village	9 350	Spring maize	77.88	0.955	5 000	1.87	5	0.374	0.370
	7 000	Spring maize	2.00	0.045	5 000	1.40	5	0.280	

3.4.4 Economic grade index of agricultural land. Via utilization grade index of agricultural land and land economic coefficient, agricultural land grade index of the designated crop could be calculated, thereby obtaining economic grade index of agricultural land in each evaluated unit of farmland quality grade.

Calculation formula for economic grade index of agricultural land for the designated crop is as below[4-5]:

$$G_{ij} = Y_{ij} \cdot K_{cj}$$
$$G_i = \sum G_{ij}$$

where G_{ij} is land economic grade index of the j^{th} kind of designated crop in the ith grading unit; Y_{ij} is land utilization grade index of the jth kind of designated crop in the ith grading unit; K_{cj} is land economic coefficient of the j^{th} kind of designated crop in isochore of the grading unit; G_i is agricultural land grade index of the ith grading unit.

Via calculation, calculation results for economic grade index of agricultural land in the project region are shown as Table 3 and Fig. 2. Seen from Table 3, land economic grade index of the project is between 494.15 and 621.34, in which 621.34 has the most extensive distribution frequency, and it has 42 distribution units, which accounts for 30% of total unit number. Seen from analysis on each administrative village, due to social economy, location and natural factors in Nanjiazhai Village, farmland in the region has higher economic grade (621.34); natural quality and land utilization degree in Mofangbao Village are higher, and its land economic grade index is also higher, which ranges between 571.91 and 600.74; economic grade is moderate in Shangmenwang Village and Xiamenwang Village, which ranges between 503.97 and 549.27; natural quality condition in Shilipu Village is lower, and land utilization degree is worse, which causes its economic index is the lowest (491.15 – 517.62).

Table 3 Frequency distribution of economic grade index in each village after land consolidation

Economic grade index	Mofangbao Village	Nanjiazhai Village	Shilipu Village	Shangmenwang Village	Xiamenwang Village	Total	Proportion %
491.15		6	14			20	14.29
503.97				7		7	5.00
505.58					4	4	2.86
517.62			4			4	2.86
531.97				25	4	29	20.71
533.67				1	9	10	7.14
547.52				3		3	2.14
549.27					1	1	0.71
552.96		5				5	3.57
571.91	2					2	1.43
600.74	13					13	9.29
621.34		42				42	30.00
Total	15	53	18	36	18	140	100.00

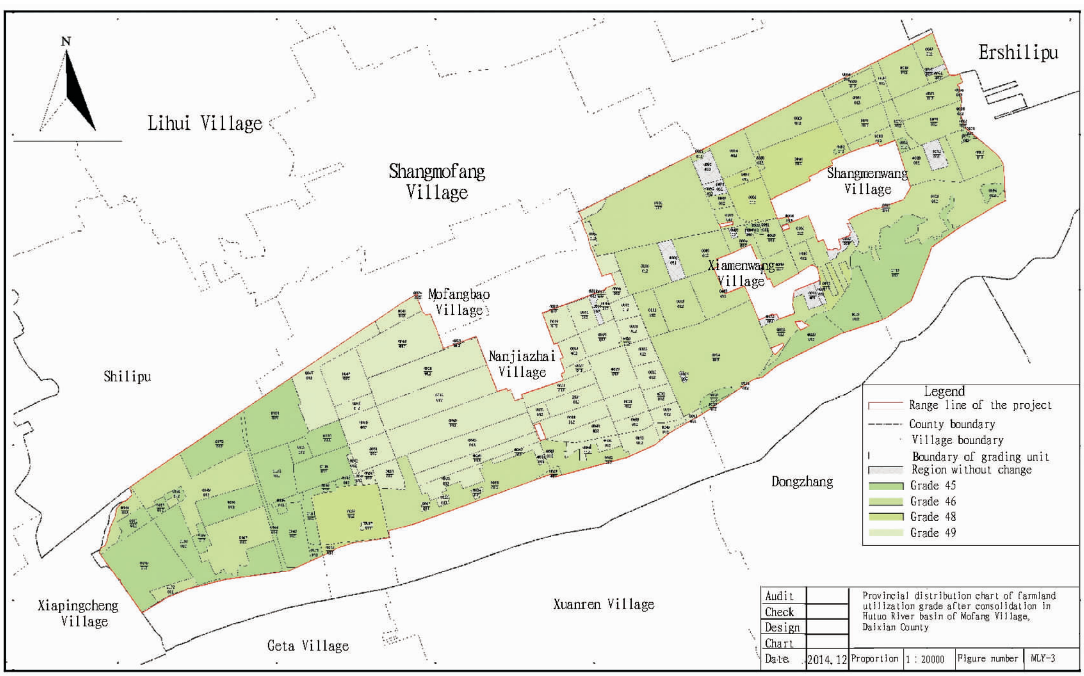

Fig. 2 The distribution of farmland utilization grade after land consolidation in the project region

4 Analysis on evaluation of farmland quality grade

4.1 Assessment of natural quality grade after consolidation

After land consolidation, natural quality of agricultural land in the project region is improved somewhat by matching irrigation and drainage facilities. Therefore, natural quality grade after consolidation distributes between Grade 45 and Grade 49. By soil covering, land leveling and matching irrigation and drainage facilities, quality on the newly increased farmland could reach farmland standard.

4.2 Comparison of utilization grade before and after consolidation After land consolidation, via integrated land arrangement and matching of field, water, road and forest, land yield in the project region is improved greatly, and land utilization grade is improved to Grades 28 – 32. By soil covering, land leveling and matching irrigation and drainage facilities on the newly increased farmland, land utilization index reaches over Grade 28. That is to say, the area of agricultural land whose utilization grade after consolidation could be improved to Grade 28 is 122.82 hm^2, which accounts for 20.23% of total agricultural land area after consolidation; the area of agricultural land which is promoted to Grade 29 is 265.52 hm^2, which accounts for 43.73% of total agricultural area

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5 Conclusions

Setting up rural land collective property right system with clear ownership, complete powers and functions, smooth transfer, and strict protection is the basic guarantee to the equal exchange of land elements. In this study, the reform of relevant legal systems to China's rural land transfer was introduced firstly, and then the guiding ideology of China's rural land transfer was proposed. Finally, the ways of practicing rural land transfer in China were discussed. Exploring the ways of equal exchange of land elements according to local conditions is an important political and economic issue concerning the livelihood and development of farmers in China, so it should be conducted under the guidance of the correct ideas to integrate scattered land in China's rural areas, develop moderate-scale management, shorten the income gap between urban and rural areas, and realize balancing development of urban and rural areas in China.

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after consolidation; the area of agricultural land which is promoted to Grade 30 is 37.25 hm^2, which accounts for 6.14% of total agricultural land after consolidation; the area of agricultural land which is promoted to Grade 32 is 181.61 hm^2, which accounts for 29.91% of total agricultural land after consolidation.

In summary, via land consolidation project, a piece of swamp and messy ridge are remedied into farmland, which increases effective farmland area. By implementing land leveling project, farmland water conservancy project, field road project and farmland protection project, and reasonly deploying distribution structure of field, water, road and forest in the project region, infrastructure supporting construction is realized, and basic condition of agricultural production in the project region is improved radically, which lays the foundation for electrification, mechanization and large-scale production. It makes that the cultivation conditions of the original cultivated land have been improved, and quality of the newly added farmland reaches the equivalent cultivated land's level, and farmland quality level is improved by one grade than before. It has an important significance for improving integrated production ability of farmland and laying a solid foundation for stabilizing grain production.

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